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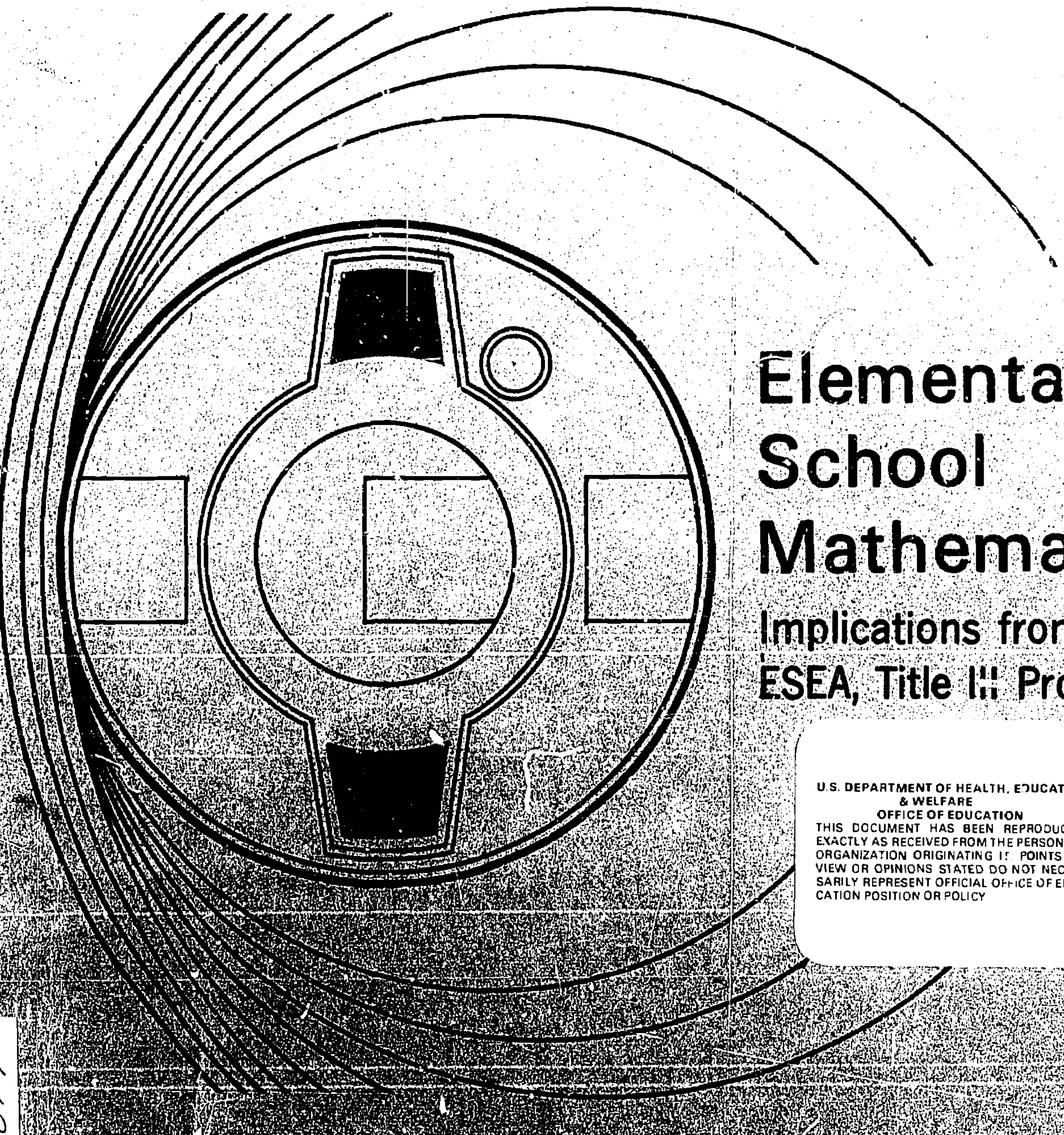
ABSTRACT

The purposes of this bulletin are to summarize selected ESEA Title III projects in elementary school mathematics; to draw implications from them for improving mathematics teaching and learning throughout the nation; and to provide assistance to local elementary school personnel involved in the teaching of elementary school mathematics, state and regional coordinators of mathematics and to college and university personnel engaged in mathematics education of teachers. An appendix lists the materials available from each project. This work was prepared under an ESEA Title III contract. This bulletin is a summary of the work of the Pennsylvania Retrieval of Information for Mathematics Education System (PRIMES). (Author/FL)

PRIMES



Elementary School Mathematics-
Implications from ESEA, Title III Projects

Pennsylvania Department of Education 1970

PRIMES
Pennsylvania Retrieval of Information for Mathematics Education System

ELEMENTARY SCHOOL MATHEMATICS:
IMPLICATIONS FROM ESEA TITLE III PROJECTS

This report is based on the work of *EDWINA DEANS*, undertaken while she was Program Specialist, Division of Plans and Supplementary Centers, Bureau of Elementary and Secondary Education, U. S. Office of Education.

Bureau of General and Academic Education
Bureau of Educational Research
Pennsylvania Department of Education

1970

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PREFACE

A portion of the funds allocated under the Elementary and Secondary Education Act of 1965 (ESEA) was designated specifically to provide financial assistance to school districts to develop model programs demonstrating workable solutions to educational problems. Programs supported under this part of the Act (Title III) utilized the findings of research in setting up and operating centers and services that were supplementary to the regular offerings available to school districts and adaptable to other school districts.

This bulletin is designed to inform school personnel on recent significant accomplishments in elementary school mathematics through ESEA, Title III projects, with emphasis upon adaptations of programs as applicable to the needs of other school systems.

Purposes

The purposes of this bulletin, therefore, are (1) to summarize selected ESEA Title III projects in elementary school mathematics, (2) to draw implications from them for improving mathematics teaching and learning throughout the nation and (3) to provide assistance to local elementary school personnel involved in the teaching of elementary school mathematics, state and regional coordinators of mathematics and to college and university personnel engaged in mathematics education of teachers.

Concerns and Needs

Preplanning for their projects, project directors, their staffs and advisory committees found definite concerns. The planners recognized the need for in-service education to help the teachers acquire background knowledge of the content and structure of mathematics, of new mathematics programs and of children's learning of mathematics. They wanted in-service education provided as a part of any project designed to improve the instructional program for children. The planners focused their study on programs which would effectively individualize the instruction of children. They wanted the disadvantaged, the able, the deficient in mathematics and the low achievers to develop competencies commensurate with their abilities and with their present and projected needs for mathematics.

Mathematics, they knew to be the subject frequently having the lowest mean scores on standardized tests and the most textbook-dominated subject in the curriculum. Reliance on a single text often not supplemented by materials and technological invention seemed to be common practice.

The programs described in this report represent attempts to alleviate some of the unfavorable existing conditions by demonstrating teaching and learning practices which hold promise for improving mathematics instruction at the elementary school level.

Organization

Selected projects are summarized under In-Service Education, Individualized Instruction, and Other Model Programs. While all projects have an in-service component, only those with in-service as a major emphasis are included in the section, In-Service Education. The section, Individualized Instruction, contains projects featuring computer-assisted instruction (CAI), computer-based instruction (CBI), individually prescribed instruction (IPI), and other projects dealing with the problem of individualization. Projects in the section, Other Model Programs, provide several model programs for improving instruction in unique ways that seem most feasible for the particular local school at a given time.

Descriptive summaries of projects and implications from them are provided in the body of the report. Appendix A lists materials available and persons to contact for further information on each project.

Some of the projects are in the second or third year of the three-year period of federal funding while others have been completed and are continuing under the resources of the local school system.

Sources of Information

Information on each project was obtained from the project proposal, interim and/or final reports of the project, telephone interviews with the project director and from supplementary materials produced by the project. In some instances an on-site visit was made to the project.

The director of each project was given the opportunity to react to the report in draft form. This publication incorporates their ideas and suggestions.

Sincere thanks are due to all current and past project directors who participated in the research projects which are here compiled.

IN-SERVICE EDUCATION

All projects funded by ESEA, Title III, have an in-service component because the success of any new or innovative program designed to improve elementary and secondary education depends upon the background and understanding of teachers and other school personnel responsible for implementing the program. The projects presented in this section, however, have in-service education as their major emphasis.

Some of the problems reflected in these projects are (1) how to provide in-service education for teachers in isolated areas, (2) how to create a multiplier effect so that the benefits of in-service will reach all teachers, (3) how to prepare teachers to make wise selections of textbooks and other instructional materials and to develop useful teaching guides, (4) how to improve the performance of elementary school pupils in mathematics through the in-service education of teachers and (5) how to use technology to advantage in in-service education.

While the selected projects do not provide final solutions to any of these problems, they do offer leads, approaches and directions which could be helpful to others seeking to improve their in-service education programs in mathematics for elementary teachers.

Use of Computer-Assisted Instruction for Mathematics In-Service Education for Elementary School Teachers

An in-service mathematics course, developed at The Pennsylvania State University, was presented to two groups of elementary school teachers. One group received the conventional lecture version of the course; for the other group the course was programed for computer-assisted instruction (CAI). Both groups participated in five hours of lecture and discussion on curriculum trends and methods of teaching mathematics. Then the conventional group continued with 20 hours of classroom instruction, while the CAI group received instruction by computer. Neither group had had in-service work in modern mathematics.

The project staff wished to determine if the CAI in-service course, the first of its kind in the country, was feasible and if it would alleviate some of the hardships teachers experienced with conventional courses. For example:

- Would the branching techniques of CAI make it possible to individualize instruction to meet each teacher's needs?
- Would the flexible time schedule of CAI prove more convenient for teachers?

What would be the effect of greater involvement of teachers in CAI which required each teacher to respond to each item in his program?

Would CAI help to meet the need for in-service education in isolated areas?

The CAI course was refined and revised as the program evolved. Whenever a number of teachers had difficulty with a particular item, the course was revised before other teachers reached that portion. No significant differences were found in the mathematics achievement or in attitudes of the two groups of teachers. The time required to complete the CAI course ranged from a low of 14 hours, 37 minutes, to a high of 46 hours and 35 minutes.

The results for the teachers completing the course (33 CAI and 33 conventional) justified the following implications and recommendations made by the staff:

1. CAI appears to be a feasible means of presenting in-service material to teachers.

2. CAI can provide successfully for the in-service education of a few teachers in isolated areas.

3. CAI can meet the individual needs of populated areas for specialized types of courses, such as a course for new teachers, a course for the re-education of teachers returning to active service, and a course for the teacher who prefers an individualized course programed for computer a teacher not frustrated by the computer or by the limited opportunities to discuss problems with the instructor.

4. The CAI method could be refined to achieve a greater mastery in teaching than the lecture-discussion method by making use of the multi-branching feature to individualize instruction.

The course, modified for a different computer, was repeated in a U.S. Office of Education institute of elementary mathematics teachers and supervisors of the disadvantaged in the summer of 1968. It is also used in ESEA Title III projects in cooperation with the Appalachian Educational Laboratory.

Improving Teacher Strategies Through Video-Taped Classroom Demonstrations

The purpose of this project is to provide for the in-service and preservice education of teachers by producing and utilizing video-taped classroom demonstrations to illustrate new content, innovative teaching strategies and the use of multimedia for individualizing instruction.

The program is a cooperative endeavor by three institutions of higher learning, 28 Southeast Texas Public School Districts and three parochial schools.

In preparation for taping a mathematics lesson, the demonstration teacher plans the lesson; discusses it with fellow staff members and mathematics consultants; designs and prepares the necessary teaching aids; does a trial run for fellow staff members, which is taped; revises the lesson on the basis of study and analysis of the tape with staff members to make improvements; and, finally, teaches the lesson to the 15 participating children for whom it is a completely unrehearsed experience. Taping occurs in a demonstration classroom equipped with a closed-circuit television system. Television cameras and audio system are remotely controlled so that only the teacher and children are in the room during the lesson.

Each film developed through this process is subjected to a three-phase evaluation. In phase one, the staff uses an evaluation instrument to evaluate each film. Measures are obtained on teacher strategies, questioning techniques, camera techniques, student response and use of materials. An overall rating is given to the film as to its usefulness for in-service and preservice education. Phase two consists of the same type of evaluation by a panel of experts. Phase three is the period of field testing by schools and colleges. During this period, further measures are obtained on the same major points.

At the present time about 18 mathematics kinescopes are in constant demand for use throughout the nation. Ten copies of each lesson are reproduced to provide for simultaneous requests. Each film demonstrates a technique for coping with a specific teaching problem.

Teaching strategies demonstrated in the area of mathematics include:[1]

Questioning techniques
Individualizing instruction
Effective discussion techniques
Inductive and deductive approaches
Exploration and discovery

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[1]Other subjects included in the project with their appropriate teaching strategies are language arts, science, social studies and foreign languages.

A discussion guide for each film gives the purpose and rationale of the film, general instructions for its use, an abstract of the contents and questions to stimulate discussion.

Because of the need of elementary school teachers for help in teaching geometry, a number of films form a geometry sequence. The geometry mathematics program is intuitive in nature with emphasis on reasoning. The student is given the opportunity to explore, experiment and discover ideas.

Project staff members have made numerous presentations of kinescopes at within-state, regional and national meetings. According to *Videobriefs* (Vol. II, No. 8, May 1968) the filmed demonstrations are in use in 25 colleges and universities to supplement classroom observation and to stimulate critical discussions in methodology.

In addition, administrators of more than one third of the states have requested the films as one means of strengthening the in-service program at points where weaknesses have been identified. The project was selected as a demonstration center for the National Commissioner on Teacher Education and Professional Standards (TEPS).

New Shoreham Telelecture Math Project[1]

New Shoreham is on Block Island in the Atlantic Ocean, about 13 miles off the coast of Rhode Island. The school system of this small isolated community recognized the need to update its mathematics program but found it next to impossible to obtain consultant help to accomplish the job. A satisfactory solution was found in using consultants from Rhode Island College to teach new concepts in mathematics by means of an amplified telephone and electro-writer system. Two-way communication was possible between the teacher and children on the island and the mathematics instructor. As the instructor's voice was heard, illustrations to clarify ideas were projected on a screen in the classroom.

The purpose of the project was to demonstrate a way of helping an isolated community move from a traditional to a modern program and in so doing to formulate a model which could be adapted to other school systems in similar circumstances. Through the telecasts pupils and teachers experienced modern mathematics simultaneously.

Instruction was provided for two half-hour periods a week for children in grades K-2 and in grades 3-5. The two local teachers supplemented and expanded the ideas presented between telelecture presentations. Weekly evening sessions were designed to acquaint parents and teachers with changes in content and methods in newer mathematics programs.

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[1] Program also included instruction for children in grades 6-12.

As the project continued, local teachers accepted more responsibility for the program as they became better prepared through the telecasts for children and adults and through other in-service efforts.

The newer developments initiated under the project are continuing as the focus of the mathematics program at the elementary school level.

Pennsylvania Retrieval of Information for Mathematics Education System Regional Center

In 1965, the Pennsylvania Department of Education initiated the development of a mathematics information system designed to assist local school districts with such time consuming and difficult professional tasks as selection of textbooks and other mathematics teaching materials and the preparation of curriculum guides. The service center, Pennsylvania Retrieval of Information for Mathematics Education System (PRIMES), provides a file of analyzed curriculum materials which have been indexed, microfilmed, and to date the system contains (1) a lesson by lesson analysis of all published basal textbook series in mathematics for grades K-6, (2) summaries of the research in mathematics of the last 50 years, (3) an analysis of eight standardized tests in mathematics for K-6, and (4) an analysis of about 150 16mm pupil instructional films and 300 filmstrips. [1]

Two major tools were used in the analysis of textbook series and standardized tests. One of these instruments, the Content Authority List, developed by nationally recognized mathematics educators, consists of about 350 mathematics concepts and skills. The other instrument, the Behavioral Objectives Authority List, based on the mathematics curriculum research work of the Learning Research and Development Center, University of Pittsburgh, is a list of approximately 1200 pupil performance objectives stated in behavioral terms. Utilizing a coding system, these instruments identify the objectives and mathematics content for each textbook lesson and test item, classify the pupil activities in each lesson by type (basic, review, extension or preparation), and record specialized vocabulary introduced for the first time. The Content Authority List is also the basis for analyzing a variety of audio-visual aids.

The file, which is accessed by computer indexes, is open-ended and can continually be updated to accommodate textbook revisions, new series, the latest research and other materials to serve the local school districts. Provision is made for changes in the authority lists as modifications are needed.

[1] Currently the system is limited to mathematics information for the use of elementary school personnel. The model has implications for expansion to higher grade levels and to other subject areas.

In 1967, the PRIMES Regional Center was established in Greensburg, Pa. to demonstrate the feasibility of using the file with local school districts in the region. The Greensburg Center is the first of a network which the project staff plans to establish to serve all school districts in the state. Additional regional centers have been established at West Chester State College and the Department of Education.

Mathematics curriculum specialists, working on a regular schedule over a period of time, serve as consultants to the local school district and assist school personnel to assess their current elementary school mathematics curriculum, construct a new curriculum guide suited to the needs of the particular district and select instructional materials which will implement the new program most appropriately. Effective use of the PRIMES system facilitates each of the three phases of this study. Modifications of the comprehensive study may be provided for school districts wishing to analyze and strengthen their current program with in-service education workshops, supplementary materials and the use of the information file in their study.

As a general service, users may address questions to the file by telephone, in person or in writing. A reference specialist searches the file for relevant materials to answer the question and prepares the answer (or selects or modifies the answer to the same or a similar question.) Advice may also be obtained on such matters as locating consultant personnel for conducting workshops.

One of the first activities of the Greensburg Regional Center was a two-week workshop at the center to train teachers and curriculum coordinators to use the PRIMES system in making curriculum decisions. Laboratory experience was provided in searching the file and in using the materials obtained.

During the 1969-70 school year, 12 school districts committed local resources and funds in working with the regional center at Greensburg. This represents approximately 200 teachers working as mathematics committee members who are actively involved in curriculum development, implementation and evaluation following PRIMES procedures, using PRIMES materials and receiving consultation from a PRIMES curriculum specialist. About 1000 teachers and 30,000 pupils are involved in the final products that result from PRIMES consulting services and supporting materials.

The services of PRIMES are ready to be made available to other states by contracting with the Pennsylvania Department of Education.

PRIMES is a curriculum project that (1) provides a systems approach, (2) uses educational technology, (3) has a comprehensive data base and (4) relates to existing state agencies and curriculum practices.

Program Development and In-service Training for Improvement of Curriculum Organization and Instruction in Carteret County, North Carolina Schools

The purpose of this project is to further the achievement of pupils by assessing curriculum and instructional needs and by planning and operating an in-service training program designed to make necessary changes as revealed by diagnostic study. Mathematics was selected as the first subject area to receive in-depth study by a curriculum and instruction committee composed of 40 teachers, principals, supervisors and four consultants.[1] Subcommittees at the primary and intermediate levels, meeting two or three times a month, conduct a thorough investigation of current status and future needs and make recommendations for ways of improving the program at these levels.

The locale of the project, Carteret County, is composed of a number of small towns and rural communities along the eastern shore of North Carolina.

Consultants from Duke University representing mathematics, statistics and education developed an evaluation instrument designed from content of the State Course of Study to be used as a pretest for teachers in the project. One consultant works with the committee on a systems development approach to curriculum planning.

An in-service course — a unique teacher-training program tailor-made for the teachers of Carteret County — was developed from the results of the pretest.

The course has two purposes: to help teachers acquire knowledge of subject matter and to consider incorporation of recommendations of the subcommittees on curriculum structure, methods, techniques, organization, media and materials, in-service needs of teachers and pupil progress. At the end of the course of 10 weeks or more for three hours per week, teachers are expected to be knowledgeable several years beyond their teaching levels.

Students will be tested in the fall and spring of each of the three years of the project. The rate of student growth during 1968-69, prior to curriculum revision and the in-service training programs, will be compared with the rate of growth for the years 1969-70 and 1970-71.

During the summer of 1969, the Curriculum and Instruction Committee composed of teachers, supervisors and consultants, carried out the recommendations of study committees in curriculum structure, teaching methods and utilization of curriculum materials.

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[1] Social studies will be included as the project progresses. Subcommittees at junior and senior high school levels are also in operation.

An important task of the committee will be the development of a flow chart of behavioral objectives in mathematics arranged in sequential order for grades K-8 in anticipation of moving toward a continuous progress program.

It is likely that some video tapes will be developed to demonstrate and disseminate information on newer techniques at the elementary level.

A Program of Teacher Re-education for Curriculum Development[1]

Major purposes of this project located in Reidsville, N. C. are: (1) to provide teachers with the knowledge necessary to individualize instruction and (2) to develop a skill-centered curriculum. More specifically teachers are guided (a) to become capable diagnosticians of children's strengths and difficulties, (b) to be able designers of curriculum experiences for children based on diagnoses of individual and group needs, (c) to achieve efficiency and economy of time in teaching and learning mathematics and (d) to develop a continuing steering committee for mathematics composed of teachers and administrators who will make decisions on the current project and who will assume also a continuing leadership role in mathematics curriculum in the schools.

The same teachers will participate in three successive summer workshops in order to develop a leadership group capable of guiding the planning of future programs, serving as resource persons for other teachers in their schools and assuring the continuation of the program beyond the period of federal funding.

Specialists in mathematics, media, educational psychology, research design and evaluation from the University of North Carolina at Greensboro, the North Carolina Advancement School and other educational institutions help teachers make in-depth studies of mathematics content, the teacher and his teaching, and the learner and his learning as related to the subject. Demonstration teachers from Norwalk, Conn. will help teachers translate theory into practice. A systematic program of consultation with consultant help and sharing among teachers will be carried on during the school year following each summer workshop.

The first six-week summer workshop (1967) focused on diagnosing learning levels and individualizing instruction. Each participant had the opportunity to observe an experienced demonstration teacher at either the primary (K-3) or at the intermediate (4-6) grade levels. Specific diagnostic techniques, approaches to individualizing instruction, and

[1] The program includes grades K-12. Other subject areas to receive similar emphasis are science and social studies.

teaching for key ideas, for discovery and for skill development in mathematics were demonstrated. Each participant had some experience in working under the guidance of the demonstration teacher.

A similar program was carried on for the second six-week summer workshop (1968). In addition, each participating teacher planned and prepared for his particular multimedia approach to individualized instruction that he would attempt to implement during the 1968-69 school year and for his role as consultant to other teachers in his school.

During the second year of the program (1968-69) Individually Prescribed Instruction in mathematics, adapted from the model developed by the Research and Development Center at the University of Pittsburgh and demonstrated at the Oakleaf School in Pittsburgh, was initiated in one elementary school. Nongraded programs and team-teaching efforts in the Reidsville Schools, prior to the ESEA Title III project, have laid the foundation for a project which will demonstrate a variety of workable solutions to the problem of individualized instruction.

Evaluation of the program by means of questionnaires and interviews have revealed that teachers are developing (1) more expertise in diagnosing children's interests and needs and in using the information obtained to design curriculum experiences, (2) less dependence on a single textbook and more ability to employ the environment and multimedia in instruction, (3) more awareness of the importance of self-concept, learning styles, feelings and attitudes in children's learning, and (4) more skill in small group and individualized instruction. There is also evidence of more active involvement of children in learning activities and more independence and a greater sense of responsibility for their own learning.

The project staff is attempting to meet recognized needs of teachers for more planning time within the school schedule for a regular program of consultation and sharing between project and nonproject teachers, and for specialist assistance in their own schools during the school year (1969-70).

Structured interviews, conducted after two summer workshops and one school year of operation, revealed that teachers are:

... using a variety of less formal ways (conversation, observation, creative experiences, children's work, children's questions and peer interactions) to study children and diagnose their needs

... using their knowledge about children to move from a textbook dominated to a more flexible, broadened and individualized curriculum

... finding that the most effective lessons are characterized by high student involvement and by responsibility for and independence in achieving his learning goals

... beginning to see more relationships between subjects

... becoming more aware of children's feelings and their effect on learning

A unique feature of the third summer workshop will be the evaluation phase of the program.

Prototype: Leadership Training Demonstrated Through a Program in Elementary School Mathematics Education

The staff of this project developed a model leadership training program in cooperation with 10 participating school systems representing different geographic areas of Massachusetts. Brookline, the most experienced of the participating school systems, played a consultative role in the development and operation of the project.

The purpose of the project was to prepare a team of educators from each of the 10 school systems to assume leadership in improving the mathematics program by providing the opportunity for each team (1) to acquire knowledge of recent trends and new developments in mathematics education, (2) to develop specific plans for strengthening mathematics at the local level, (3) to select or develop the materials required, and (4) to plan for the implementation of the program during the next school year.

A six-week live-in summer institute provided participants with (1) basic courses in number systems and geometry, (2) laboratory time for exploring current mathematics materials, (3) lectures by consultants on learning theory and its implications for curriculum development, (4) group discussions among participants, resource personnel and staff, and (5) work session. The experienced Brookline staff and the project staff and consultants provided guidance in writing curriculum and guideline materials and in drawing up recommendations to the administrative staff of the local system for implementing the plans and suggested procedures.

While the leadership workshop was in progress, a local educational television station produced and broadcast three one-hour programs demonstrating new ideas in curriculum development and in the teaching of mathematics. The broadcasts, presented live, were repeated for an expanded audience and later kinescoped for use at educational conferences and for in-service education purposes by local school systems.

The project staff demonstrated that, through collective action by a number of cooperating school systems, extensive human and material resources could be provided far beyond what would be feasible or possible for a single school system. Furthermore, there were innumerable opportunities for the team from a given school system to share in the accomplishments of the other teams.

During the 1967-68 school year, each team was responsible for implementing the curriculum materials developed during the workshop. Typical sample activities included:

... trying out materials designed to supplement the course of study and textbooks used (among these were curriculum materials for slow and able learners; units on special topics, such as numeration and geometry, a kindergarten curriculum and materials to individualize instruction)

... sharing with others in the local school system through planned in-service workshops and demonstration lessons

... making recommendations to school officials for immediate and long-range plans to be implemented, such as changes in curriculum and materials to be purchased

... obtaining the services of consultants from the project staff to assist with implementing curriculum changes during the school year.

Plans and procedures developed by each team reflected the needs of each community and the level previously attained in moving toward a more modern mathematics program. Two members of the project staff continued to serve as resource persons during the implementation period by giving demonstration classes, speaking at PTA meetings, consulting with school personnel on local problems and publicizing results at regional educational meetings. Results reported by the teams after one year of implementation of the program included:

... gathering, compiling and creating mathematical games and devices emphasizing a discovery approach to the development of concepts, patterns and relationships to serve as a supplement to the curriculum guide

... preparing new units on geometry to supplement the mathematics materials for grades 5 and 6

... drawing up plans for meeting individual differences more adequately with particular attention to slow learners (plans covered diagnosis and records of pupil progress)

... developing a course guide for mathematics in the kindergarten

... distributing materials produced during the summer throughout the school system and conducting implementation meetings with teachers

... developing a curriculum for the sixth grade with detailed activities in the newer mathematical concepts and approaches.

Teams recommended to their respective superintendents, immediate and long-range procedures for improving the mathematics program. A sampling of these follows:

> Set up a Central Lending Supply House for integrated mathematics and science materials. Staff center with directors, secretaries and librarians and provide workshop facilities.
>
> Circulate to all teachers a monthly newsletter on new developments in mathematics and local activities.
>
> Hold workshops to introduce new guide materials, to demonstrate content, methods and use of manipulative devices, and to obtain feedback from use by pupils and teachers.
>
> Provide for teacher participation in regional meetings of the National Council of Teachers of Mathematics.
>
> Earmark funds for supplementary and enrichment materials in mathematics.
>
> Offer a course in modern mathemtics for parents.
>
> Provide local in-service workshops and other opportunities for teachers to continue their study in mathematics education.

Implications for Mathematics Education

The few school systems geared for computer-assisted instruction will be interested to learn of its possibilities and effectiveness for in-service education. Teachers can use the computer after school, in the evenings or on Saturdays when programs for children are not in operation. CAI offers one way of reaching teachers who otherwise must travel long distances to participate in an in-service course or who prefer to work at their own pace through content material. Alternatives should be available, however. Some teachers learn much from associations with coworkers and from group interaction with an instructor who invites questions and discussion.

Perhaps periodic contacts of this nature could be arranged to supplement a CAI course. It is conceivable that certain objectives are more adequately met by CAI than by other methods. If so, further demonstrations might help to delineate these and to determine what combination of CAI and other methods is most profitable and satisfying for teachers. Occasionally, a teacher may experience frustration when working at a computer or with programed materials used by school systems without CAI facilities. When stumbling blocks are encountered, such a teacher needs the confidence and assurance generated by an understanding instructor.

The technique of video taping selected short segments of learning experience is proving its worth for in-service education. A team of teachers and consultants alternate in the roles of teacher and supporting member. The teacher responsible for the demonstration designs a teacher-learning experience which has been planned with the team. After a dry run for the reactions of the team, the teacher guides a small group of children through the learning experience as a video tape of the demonstration is made. Next, the video tape is studied by the team and suggestions resulting from the critique are incorporated into the revision. The teacher then reteaches the lesson and the final tape is prepared for wide use in the in-service training program for other teachers.

Tapes may be produced to disseminate information on methods, materials or content new to a school system. Ways of working with children of different abilities, of individualizing instruction and of diagnosing learning levels of children could also be demonstrated. A library of tapes would be an excellent source of help for the in-service education of new teachers or those returning to the profession after an extended period away from the classroom.

Does the sequence of plan, teach, critique and reteach present a useful model for in-service education for school systems without videotaping equipment?

By means of the telelecture technique, a consultant at Rhode Island College introduced the remote Block Island community to some of the concepts of modern mathematics. Beamed to teachers and students during the school day and to teachers and parents in the evenings, the telelectures served to ease the transition of the school and community from a traditional to a more modern mathematics program. The teacher received help also from the supplementary materials developed for each telelecture.

Telelecture is often used to bring the contributions of experts to in-service education groups when it is not feasible for the expert to appear in person. Sometimes the in-service group submits a list of topics in advance of the scheduled telelecture. Two-way communication is possible, however, and questions or comments by the in-service group may be entertained on the spot.

Tasks such as selecting textbooks and other teaching materials and developing teaching guides have frustrated curriculum committees for years. In spite of tremendous expenditures of time and effort, committee members feel defeated by the magnitude of these jobs. Utilizing information systems like the one developed by the Pennsylvania Department of Education can make a substantial reduction in the man hours required and increase considerably the confidence of committees in the results of their efforts.

The system can provide information on textbooks, tests, films, filmstrips and other materials available for mathematics instruction, the findings of research on topics of concern to elementary teachers and even the answers to individual questions of teachers related to mathematics. In order to use it effectively, a local school system receives consultant help from the Department of Education or from a regional center such as the one at Greensburg, Pa. in assessing its current mathematics program and in setting future directions. On this base, local decisions and production can be fitted to the needs of the particular locality.

The cost of establishing and staffing this information center probably prohibits its wide replication. In fact, replication in mathematics would be neither necessary nor desirable. If the model could be used to establish similar centers for other subject areas, contractual or exchange agreements might be worked out between centers.

Three in-service projects focus on the efforts of local school systems to develop the teacher's background in mathematics and strengthen instructional procedures so that improved pupil learning of mathematics will take place. These school systems are using the talents of their own school personnel and consultant help from colleges, universities and other school systems to meet their most urgent needs for in-service education. The programs are characterized by a dual emphasis on mathematics content and on classroom application. Mathematics course work adapted to the needs of participants and workshop-laboratory-demonstration type of experience combine theory and practice in a manner appreciated by the elementary teacher and effective in bringing about changes in teacher and pupil performance.

Laboratory experiences include:

1. Observations of demonstrations in which the learning level and difficulties of an individual pupil were diagnosed and recommendations made for appropriate learning experiences on the basis of the diagnosis (later each observer has the opportunity to practice these new skills under the guidance of a demonstration teacher)

2. Examination of teaching materials, including those produced by recent demonstration projects which have received nationwide recognition

3. Development of materials and teaching procedures

4. Exploration of multimedia approaches to teaching

5. Implementation plans for new developments in the classroom.

These projects demonstrate that teachers learn from and are changed by the experiences in which they participate. Under guidance many of them become effective leaders and teachers capable of bringing about similar changes among their peers.

INDIVIDUALIZED INSTRUCTION

Projects presented in this section represent various ways of meeting the problem of individualizing instruction for children. For years the lone teacher with a typical class has recognized the importance of this objective but has found it almost impossible to achieve. A more scientific approach to individualized instruction is achieved by capitalizing on technological advances and by providing training for teachers and support personnel to supplement the work of the teacher.

Selected projects demonstrate the following features of successful individualized instruction programs: (1) objectives are stated in terms of observable pupil behavior, (2) the major role of the teacher is to manage and guide the pupil's self-learning and (3) the pupil gradually assumes responsibility for his own learning and grows independent. Some projects attain individualization by using computers; others, by developing instructional systems into which all available learning materials and resources are organized. Individualization of instruction is ordinarily limited to one or two subjects at a time while the school operates as usual in other areas.

Awareness of differences in learning aptitudes and abilities is only a prelude to providing and managing a relevant learning environment for each child. School personnel will find some help toward this goal in the projects presented.

Common Characteristics of Computer-Assisted Instruction Projects

Computer-Assisted Instruction (CAI), as used in this report, refers to the drill and practice program in arithmetic developed at the Institute for Mathematical Studies in the Social Sciences, Stanford University, by Professor Patrick Suppes. Computer-based Instruction (CBI) is the term used for a similar program developed by an industrial instructional center.

The primary purposes of the drill and practice programs are to:

... individualize instruction

... provide continuous progress

... diagnose pupil difficulties

... conserve teacher time for the developmental phase of instruction

... increase student interest and motivation

... increase parent interest in the student's work

... provide immediate feedback to reinforce learning

The projects at McComb, Miss., and Paintsville, Ky., are demonstrations of the Stanford CAI program. The New York City project (CBI) demonstrates the cooperation of industry with the school system in planning and operating a computer program. These demonstrations determine if computer drill and practice programs can be operated successfully in communities, geographically far removed from the original computer source and represent different pupil and teacher populations. In each of these programs, pupils receive drill and practice exercises at computer-based, remote-controlled teletypewriter machines located in the participating schools.

The drill and practice program can: (1) present a series of problems to which the child responds by punching keys on a teletypewriter machine, (2) provide the student, teacher and parent with a summary of correct and incorrect answers and the time required for each lesson, (3) provide the teacher with a cumulative summary of results for all students in the class and (4) select the next appropriate lesson for each child which may be on the same level, easier, or more difficult, depending on the pupil's responses to the previous lesson.

Lessons representing 24 different concepts are available for each grade, one through six. Lessons are arranged in seven-day blocks on five levels of difficulty. From three to five weeks prior to the time the block of drill work is selected, the concept has been presented by the teacher in the developmental phase of the program.

The first lesson in each block of drill and practice is a pretest administered to determine the child's grasp of the concept. On the basis of his score on the pretest, the difficulty level of his first practice lesson is selected by computer. Performance on each lesson in the block determines whether the next lesson selected is on the same difficulty level, or on the next higher level (if 80 per cent or more of answers are correct) or the next lower level (if 60 per cent or less of answers are correct).

Each lesson combines review of previous work or maintenance with practice on the more recently presented concept. Length of practice periods varies from three to fifteen minutes per day per child. Each teacher, using one of the computer drill and practice programs, selects the order of the blocks of drill work to correspond with the developmental program of the local system, the course of study, the textbooks used and the needs of the children in a particular class.

The Stanford-Ravenswood CAI Project, the fourth described in this section, demonstrates an extension, refinement and revision of the original Stanford drill and practice program. The adjustment of content to a strand format represents the fourth revision of the drill and practice materials.

Differences with regard to population, geographic location and teacher education are presented in descriptions of the separate programs.

Computer-Assisted Instruction in Mathematics

In 1967, the city of McComb and two surrounding small rural school districts in Mississippi initiated their CAI program with 21 teletypewriter machines, a staff of 20 teachers and 780 pupils. In preparation for their own project, the McComb teaching staff participated in a four-week training workshop at the Stanford CAI Center in the summer of 1967. With members of the Stanford staff to guide them, teachers became familiar with the program, learned to write behavioral objectives for pupils based on their own course of study and text materials and to select blocks of practice lessons to achieve these objectives. They also had practical experience with the lessons at the teletypewriter.

For the 1968-69 school year, the program expanded to include 81 additional teachers in the training program directed by the University of Southern Mississippi at Hattiesburg with the assistance of the Stanford project staff. The original group of 20 teachers helped provide in-service training for teachers new to the program.

Training for the second year of the project convinced the staff that teachers could operate successfully in the program with a basic course in mathematics and approximately 20 hours of instruction directly related to the CAI instructional program. Apparently, teachers who received the shorter training course performed as well as those who had the four-week course the previous summer.

In the second year expansion (1969-70) the number of student terminals was increased to 60 and made it possible for every child in the school district to receive the CAI drill and practice materials. Both teachers and pupils adapted themselves to the machines with relative ease; the younger children made a more rapid adjustment even than the older. Teachers reacted to CAI as a normal part of the daily schedule.

A progress report of the project provides a comparison of experimental and control groups on development of basic skills, concepts and applications for the first year of the project (1968-69), presents plans for the second and third years (1969-71) and offers a tentative solution for continuation following the three years of federal funding.

Scores on a standardized achievement test, administered in 1967 and repeated in 1968, showed significant gains (.01 level) for experimental (CAI) over the control groups (regular) in each of the grades 1-6 on arithmetic computation. A breakdown of results indicated that disadvantaged children in CAI groups learn mathematics better and retain it longer than disadvantaged children in regular groups. This was true for computation, concept development and the ability to apply mathematics.

During the final year of the project (1970-71) the staff expects to explore the possibility of supplementing the CAI program with data processing services, already available, to reduce the cost of the program and to serve large numbers of pupils in order to assure the continuation of the program beyond 1970.

Individualized Computer-Aided Instruction

This project located in eastern Kentucky has been in progress since 1968. The Paintsville Board of Education serves as the fiscal agent for the 20 counties and 30 participating local school districts. The project demonstrates and evaluates the CAI drill and practice program in a rural and semirural area of Appalachia. Under a subcontract with Stanford University for computer time and for the use of the drill and practice materials, the CAI program is relayed to project schools through a small communications computer at nearby Morehead State University.

The Central Midwestern Regional Educational Laboratory (CEMREL) has a subcontract to conduct a project evaluation to determine (1) the extent to which the objectives of the CAI program are reached, (2) the effectiveness of the computer for rural areas and (3) the impact of the program in rural Kentucky.

During the early phase of the project, pretests were administered to students, teachers and parents who were to participate in the project. Initial in-service workshops were conducted by professors from Stanford and Morehead State Universities. Regional teacher-education workshops for project teachers have continued under the leadership of Morehead State University.

A preliminary evaluation report from CEMREL after the first seven months of project operation indicates:

1. An average student gain in computation skills of 1.45 (1 year, 4½ months)
2. High acceptance of the program (9 to 1) by teachers and parents
3. Anticipated levels surpassed in individualizing instruction, student acceptance, involvement and interaction with the curriculum
4. More rapid and longer retention of learning
5. Improved attendance of habitual absentees
6. Increase in self-confidence of educationally disadvantaged students
7. Increase in parent interest in children's school work
8. Improved teacher attitude toward innovation.

The CAI program was also used with high school Upward Bound students in a six-week summer school. An average gain of.8 (8 months) was realized with a few students showing as much as two years' growth. Currently, the program is offered at four sites for adult education students.

Planning and Pilot Implementation of a Computer-Based[1] Instructional Program

In contrast to the two previous projects, this one, encompassing three boroughs in New York City, will determine the feasibility of working with industry to conduct a computer-based[2] drill and practice instructional program in a large city school system. Classrooms at 16 school sites are equipped with computer-based instruction (CBI) student terminals where 6,000 children in grades 2-6 receive daily drill and practice lessons in mathematics. The program is presented to adults also as part of the Board of Education's evening adult program.

In-service training of teachers and parent orientation to the program are components of the project. Consultants from an industrial firm serve the project full time. Two fully trained instructors know the program and assist with in-service and other instructional needs. Five technicians keep the hardware in working order.

This program, beginning in March 1968, utilizes the CAI drill and practice materials supplied by a publisher. A six-week summer workshop (1968) produced a cadre of trained instructors who conduct courses for fellow teachers in classes of about 20 each. Eventually this core group will develop lesson guides and instructional kits to articulate the program more completely with the New York City mathematics curriculum.

One measure of effectiveness of the program will be a comparison of schools in the project with an equal number of control schools on prescores and postscores on the Metropolitan Achievement Test. Interviews with pupils, parents, community personnel, teachers, principals and supervisors selected by random sampling will reveal attitude changes in both the experimental and control groups. The learning processes of pupils in the classroom and at the terminals will be observed and evaluated by means of scales developed for the purpose.

From March through the remainder of the year, 1967-68, the New York City program operated by means of a hookup of telephone lines with the Industrial Computer System. Since the beginning of the 1968-69 school year, the program has operated through a central computer located in mid-Manhattan with subsystems in Manhattan, the Bronx and Brooklyn. There are 192 student terminals with approximately 13 in each school. Evaluation will determine whether it is more satisfactory to have one terminal in a classroom or a number of terminals in a central location within a school.

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[1] In addition to mathematics for grades 2-6, this program will include spelling and reading for grades 2-6 as well as remedial programs for high school and adult groups.

[2] There is no distinction between the meaning of the terms computer-based instruction (CBI) used in this project and computer-assisted instruction (CAI) used in the other two projects described in this section of the report.

Stanford-Ravenswood Computer-Assisted Instruction Project

Under this project the drill and practice mathematics program, which has operated successfully in the Brentwood School, will be transmitted by teletype machine to each of the Ravenswood District's eight schools.[1] The units or blocks of content have been adapted to a strand format that affords greater flexibility and more opportunity to adjust content to the needs of individual children.

A strand is a series of examples of the same operational type (counting and place value, addition, subtraction and fractions) arranged in sequence according to difficulty. Each strand begins with first grade and extends into the junior high school level. A child can operate any place on this continuum without the necessity to return to a common point at the end of a definite period as required by the concept block format. With this approach greater individualization is achieved because (1) each student's lesson is prepared for him daily by the computer, (2) mixed drills are presented in each concept at a level of difficulty determined by the student's prior performance in that concept and (3) the student moves up each strand at his own pace.

The computer alternates the pupil from one to another of the strands, making the choice of strands and selection of lessons within each to achieve variety and to meet the greater need of the child for one strand over another at a particular time. Each day's lesson presents examples at grade level, above grade level and below grade level and provides more practice on areas of weakness. Weekly reports provide the teacher with the position of each child in each strand so that strengths and weaknesses are readily apparent.

Many features of the earlier Stanford drill and practice programs remain in effect. Among these are workshops in programed learning, computer-assisted instruction and weekly conferences at which teachers, laboratory personnel and administrators study and make decisions through use of the weekly computer report for each child.

Comments on Computer-Assisted Instruction Projects

The majority of teachers in McComb Project - in operation longer than the two other programs described - are enthusiastic. Relief from the need to correct written work and daily access to the results of the drill and practice lesson for each child enable them to know each child better than before. Knowing who needs help and what kind makes the teacher responsible

[1]The reading program developed at Brentwood School for the primary grades will be included also.

for providing assistance at the opportune time so that continuous progress can be maintained. Though teachers do not find their overall work load lightened, some find more time, now, to devote to the creative phases of mathematics.

The majority of children have held a sustained enthusiasm for the program for the two years of the McComb project and no longer than that for the original Stanford program. A printout of each child's daily lesson amounts to a daily progress report for the parent.

In the first-year evaluation report of the McComb project, teachers recommended that student terminals be placed at a central location in the building rather than in each classroom. The New York project will provide data which will help to determine if one of these alternatives is more satisfactory than the other.

The Eastern Kentucky project staff summarizes the unique capabilities of the computer, demonstrated and researched through their project as follows: The computer, a sophisticated instructional aid, has proved itself effective in stimulation and motivation, in providing immediate reinforcement and correction procedures and in transfer of learning. Computerized instruction is especially effective in compensating for significant differences in individual rates of learning.

Close adaptation to individual performance appears to be the greatest strength of the computerized program. The computer can assign each student to his level of ability based on previous performance and on current progress. It automatically adjusts to the student's ability level and constantly leads him to more advanced problems as he progresses.

The objection has been raised that some modern mathematics programs neglect the drill and practice in order to place more emphasis on structure and understanding. If this objection is justified, an individualized, computerized program, such as CAI, appears to be a highly satisfactory means of providing supplementary drill and practice. Teachers appreciate the capability of the CAI system to identify specific pupil deficiences, to individualize simultaneously the presentation for many children, to correct errors immediately and to provide both daily and cumulative results.

The opportunity to accumulate masses of data on individuals and groups of children suggests problems for research in child learning, some of which will be explored in the evaluations of these projects.

Individually Prescribed Instruction
(Project for Educational Innovation)

This project, sponsored by the Monterey, California Public School System, is designed to field test the Individually Prescribed Instruction (IPI) Program in mathematics developed by the Learning Research and Development Center at the University of Pittsburgh and demonstrated at the Oakleaf School in Pittsburgh.[1]

The Oakleaf School mathematics program provides a seven-year (K-6) sequential curriculum defined by means of some 450 objectives stated in terms of pupil behavior. The content is divided into about 80 blocks or learning units representing nine levels, A through I. Each level is subdivided into 13 units, including numeration, place value, the four operations with whole numbers and fractions, systems of measurement and geometry, and certain special topics.

Materials for the program are selected from commercial texts, workbooks and programed materials, films and filmstrips, slides, listening tapes, games, etc., and all are assigned to specific behavioral objectives. Initial placement of the child to a given level in the program is determined by a broad, general pretest. Pretests precede the assignment of each learning unit. Progress through the unit and grasp of the content is evaluated by curriculum tests and posttests to assure that each student is working on a skill he has not yet learned but for which he has the prerequisite skills. Each child proceeds through a unit at his own rate completing as few or as many lessons as needed to demonstrate a proficiency of 85 per cent or better on the material.

Most of the teacher's time is spent in helping individual pupils, discussing their progress in staff conferences, evaluating and adapting materials and procedures and in planning the next work or in writing individual prescriptions for each child. A prescription may be an assignment to any of the materials available for the specific objective, assignment to a teacher for individual tutoring, or for instruction in a small group of students having similar needs. A teacher's aide assists with record-keeping and other clerical tasks.

The per pupil cost of the program is estimated at from $37 to $115 more than a regular instructional program depending on the amount of financial support a school system is already providing.[2]

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[1]This program will also field test the IPI Reading program developed by the Research and Development Center at the University of Pittsburgh.

[2]Individually Prescribed Instruction, Education U.S.A. Special Report, p.3, National School Public Relations Association, NEA, 1201 16th Street, NW, Washington, D.C. 20036.

The Monterey demonstration of IPI was preceded by a two-week summer workshop for all teachers in the program. During this time teachers became familiar with the basic features of IPI and had practical experience in administering the program for a group of children. In the IPI mathematics program, all children in grades 1-3 from one school and all children in grades 4-6 from two other schools are involved. Participating schools represent diverse nationalities and socioeconomic background. Students devote one hour per day to IPI. The regular program of a school is followed for the remainder of the school day.

Teachers hold weekly meetings to discuss the progress of individual pupils. Each school has two instructional aides who assist with correcting worksheets and tests, charting pupil progress, preparing pupil data sheets for teachers' use in diagnosing the appropriate working level for pupils and in prescribing lessons.

In the Oakleaf School, where IPI has now been in operation since 1964, charting of mathematics achievement, as measured by units completed, indicates that in any given grade, more pupils achieve at higher levels each successive year of the program. After five years of IPI at Oakleaf School tentative results of the demonstration furnish evidence that the majority of children in the program perform on skills approximately one grade level above traditional grade placement and that many children perform two or more grade levels beyond.

A similar pattern appears to be emerging from the Monterey project. After the first year a comparison of project schools with comparable nonproject schools revealed that IPI students did not do as well on standardized tests as the nonproject schools. Since preliminary results for the second year show greater gains for IPI than for comparison students, the project staff feels that the following factors had substantial influence on the results: (1) the first year in IPI was spent mainly in filling gaps in previous learning for individual children, (2) considerable difficult was experienced in implementing the IPI program due to delays in obtaining materials in sufficient quantity and range for some units and (3) standardized tests lack the breadth essential to an accurate assessment of IPI skills.

On the positive side, children in IPI are more interested in learning and more motivated to learn; they learn more thoroughly what they learn and are more self-directed and independent. Arithmetic is the favorite subject for IPI and fourth for non-IPI students. After the routines of the system become thoroughly familiar to students, study habits improve, a busy hum sounds in the classroom and discipline problems are almost nonexistent.

Teachers and administrators are convinced that the individualization of instruction is indeed feasible. Through local support the program has expanded to other schools and school districts. Except for one school in a poverty area, project schools will continue IPI at their own expense, following the period of federal funding.

While teachers working in IPI are generally enthusiastic about the program and its possibilities, some express concern that the program appears to be more successful with average and able than with slower learning pupils and with pupils in later elementary than with those in early elementary grades. Attempts are being made to overcome these disadvantages by providing seminar discussion groups, small group work as like needs of several students are identified, and teacher and peer group tutoring for slower children. Audio tapes are used for younger children whose reading skills are not yet functional.

School systems using the program report a general trend toward the individualization of instruction not only in mathematics but in other areas of the curriculum, in all grades of the elementary school and with teachers outside the program as they become familiar with the principles of individualization and are encouraged to apply them in their own classrooms.

A Multi-Discipline Educational Center for Individualizing Teaching and Learning

The McNeill School in Bowling Green serves as a center for demonstration of individualized instruction in several subject areas for 43 school districts in 29 counties in west-central Kentucky. [1]The mathematics team consists of mathematics teachers (learning coordinators), counselors (learning analysts), teacher aides and student teachers. A media specialist and a mathematics consultant are available to the team.

The center is divided into two large learning areas, each with its own materials, audio-visual aids and equipment. Plaza A provides for children in the first four years of school (roughly grades 1-4, or years 6-9); Plaza B for those in later elementary and junior high school grades (grades 5-8, or years 10-13). The library is an integral part of both plazas.

In the ungraded program children progress at their own pace through academic learning packages or kits especially prepared to meet specific objectives in mathematics. Kits for the younger children draw heavily upon a basic text supplemented by staff prepared materials. An academic learning package for the older group contains specific objectives followed by references to specified pages in several commercial texts and to filmstrips and

[1] In the first year of the project individualized instruction was demonstrated also in reading, science and language arts. In the second year the curriculum areas were expanded to include art, music, social studies, speech and drama. Also tried for the first time is the OAV (Oral-Aural-Visual) Language Arts Program developed at the Burris Laboratory School at Ball State University, Muncie, Ind.

drill tapes which deal with the topic. Kits also include selected commercial worksheets, supplementary exercises prepared by the staff, and "Excursions" which take some children into the topic in-depth. A letter to parents lists the objectives for the learning package.

In the middle years, major emphasis centers on independence in study and the use of learning materials and media, and responsibility for making decisions on the amount of time to be devoted to a given subject area. One child may devote three 20-minute modules to mathematics while another may need only one or two.

A part of each child's Learning Performance Profile is his Behavioral Independence Level or the extent to which he may be expected to assume full responsibility for his progress through the curriculum. Teachers' judgments concerning attitude toward learning and emotional and social maturity are used in arriving at his Behavioral Independence Level. In turn this index is used in developing the details of his individualized program and in allocating time in the resource areas and the services of teachers and other team members needed by him.

Teachers provide individual assistance to students as they progress through a learning package. When a kit is completed the child and his teacher evaluate the work and decide on the next learning package. The counselor administers tests, interprets test results, develops learning profiles for each student and participates with teachers and others in team evaluation of each child's progress.

Each participating school district sends one person in each subject area and one in guidance and counseling for a two-day workshop before school begins in the fall and for two five-day periods during the year to work with the teaching teams at the center. With assistance from the center and college consultants, each participant follows this experience with 24 hours of in-service education for the teachers in his own district.

Almost all of the teachers from other districts who have participated in the program report that they have adapted some phases of the center program for use in their own classrooms. Some begin by individualizing instructions in only one or two subject areas.

Teachers were asked to state the things they do differently in the center program than in their pre-center teaching experience. The following differences listed by teachers summarize some of the highlights of the center program:

1. There are no grade levels. The school is divided into two educational plazas: Plaza A and Plaza B.

2. There is no assigned homework although by choice students do approximately one third to one half of their work outside of school. They thereby shorten the time spent on an academic package and complete more work.

3. Children use a variety of materials included in academic packages in contrast to assignments in textbooks.

4. Resource or learning centers, including the library, foster individualized learning.

5. Every teacher of mathematics is a specialist and devotes full time to it.

6. Every student in Plaza B has an individual schedule.

7. There are no numerical or alphabet scores or grades. Results of teacher-student evaluation are reported to parents. This form of reporting is supplemented by a written report twice each year and by teacher-student and teacher-parent conferences. The counselor is available for conferences on standardized test results when parents request this information.

8. One of the program directors is a mathematics specialist (others are specialists in other subject areas).

9. The media specialist trains students to use all equipment.

10. Aides and paraprofessionals work with both pupils and teachers.

11. The counselor does academic counseling only.

The Bowling Green School system intends to continue the project after Title III funds are phased out. The major cost involved in the continuation will be in the reproduction of materials. As a result of the project, several schools in the region are embracing similar approaches to the teaching of mathematics.

Implications for Mathematics Education

Computer-Assisted Instruction (CAI), Individually Prescribed Instruction (IPI) and modification of CAI and IPI which are developing as these programs are implemented over the country will undoubtedly become a part of the elementary school of the future. Educators must continue to seek the phases of the mathematics curriculum which are most appropriate for individualized instruction techniques and those that may be accomplished more effectively by some form of group instruction in paired learning, small groups, regular classroom size of 25-30 or larger groups. Consideration must also be given to types or combinations of types more likely to motivate students, to maintain their interest and to foster creative thinking. Equally important is determining which students learn best operating as individuals for a major portion of the time and which respond more readily to the stimulation of group interaction.

It is only after different approaches are at least partially developed that school personnel can begin to consider the mixes and matches which will accomplish all the goals of a complete, well-rounded mathematics program.

The major deterrent right now to wider use of the CAI drill and practice program in mathematics is cost. While some reduction in per pupil cost has been achieved, further reductions must take place before school systems with moderate budgets will be able to support a CAI program. Developments are under way to reduce the cost to about 25 cents per pupil per hour.

Until cost is reduced, some educators see the major function of the computer as that of managing instruction. Instead of pupil interaction with the computer as in CAI, the teacher uses the computer to handle some of the clerical tasks and records needed in the administration of the program and to guide each child in the instructional process. For example, a computer-management system can support an IPI program or an individualized program of the type operated by the McNeill School in Bowling Green by supplying the teacher with continuous, current information that can be used in diagnosis, assessment and prescribing the next work for each child.

At the present time in both CAI and IPI the curriculum in mathematics is predetermined by experts or by experts and teachers working together. There is, however, flexibility in selection of the parts of the program needed by each individual pupil. An unsolved problem is how much of the mathematics curriculum and what content should be programed for presentation and how much and what content should be self-selected and self-directed by the student as he uses all resources available to him. These resources may include the computer as a teaching tool or as an information storage and retrieval facility.

The New York City project demonstrates the cooperation of industry with a local school system in solving the problem of individualized instruction. Perhaps through such joint endeavors of those who develop machines and those who use them, improvement can be made so that computers will better serve children and their learning in both the teaching and management roles. According to some authorities most of today's technological hardware was designed for business, industrial or entertainment purposes. To serve education adequately, considerable redesigning and redevelopment may be necessary.

The Monterey and Bowling Green projects demonstrate two different ways of developing and operating a systems approach to individualized instruction. In these projects all relevant materials available to the school system are programed into a system. The teacher prescribes particular phases of the system on a daily or periodic basis, according to the pupil's readiness, past progress and interest. Films and filmstrips, for example, which have never been widely used by the majority of teachers, become more useful when the teacher can see their relevance for accomplishing certain specific objectives in the learning sequence. Selected and programed into the system as an essential and integral part of it, they are readily available to the teacher and students at anytime they can make the greatest contribution to each child's learning.

These project staffs are striving for systems with sufficient flexibility so that continuous changes in the nature of substitutions, additions and deletions of content and materials are possible. When it was found that adjustments were necessary to accommodate younger children and nonreaders, the Monterey project staff introduced a machine with the capability of presenting oral instructions and visual displays simultaneously to the individual child. The McNeill School staff adjusted their program to provide more teacher guidance and direction for the younger children. Teachers in both of these projects are questioning the feasibility of programed instruction materials for slower children, and they are prescribing more group or seminar type of work with the teacher. On the basis of the results of these and similar projects, future directions on such issues may be clearer.

OTHER MODEL PROJECTS

Unique Developmental Projects

Each of the projects presented in this section has unique features that build upon the existing mathematics program in the particular school system involved. The Pittsburgh, Pa. project utilizes instructional films as the nucleus of a systems approach to improving mathematics instruction for children in the lowest ability quartile of fourth graders in the city. Besides a program developed for this target population, instruction is further differentiated for subgroups within each class.

In the Greensboro, N. C. project each of four model schools is using a different organizational framework for mathematics instruction. Rather than any attempt to prove that one pattern is superior to another, the goal is to demonstrate that the learning of mathematics can be improved within each of the four patterns. The staff, of course, must believe in the plan, receive in-service education to become knowledgeable about it and get the support of human and material resources to implement it. Naturally, the school personnel will also be concerned with differences demonstrated by the four models as they make post project recommendations for mathematics education in the city.

The Woodbury, Iowa project demonstrates that it is feasible to improve the teaching and learning of mathematics within the self-contained format. Although this organizational pattern is widely used in elementary schools, there appears to be a trend toward the departmentalized approach in Iowa as in many other sections of the country. Teachers representing both organizational plans participate in the project and learn ways of differentiating content, materials and methods to meet the needs of groups and individuals in either type of classroom.

The Southwest Missouri Educational Improvement Center project illustrates the assistance that local school systems may receive as they work cooperatively with a regional center. Staffed to provide consultant service and resource materials for local school systems within the region, the center is equipped to help a school plan and operate new programs which it decides to undertake.

Because of limited operating budgets, many school systems find it necessary to make improvements in their mathematics programs by building onto the existing base. The projects reported in this section will have special interest for such school systems.

The Development of Four Model Elementary Programs for Teaching Mathematics with Implications for Other Subject Areas[1]

Located in Greensboro, this project came into being because of the belief of the staff and teachers involved that an effective program in mathematics could be demonstrated with several organizational patterns. Four schools were designated, each using a different organizational framework, to demonstrate model mathematics programs in grades 4-6. Success would be determined by improvement made in the mathematics teaching and learning for all students in the model schools and the extent to which the model fostered exploration and experimentation to achieve desirable changes in mathematics education.

Participating schools made first, second and third choices of organizational plan. All teachers (except two who transferred to a nonproject school) of the selected schools agreed to work in the particular program assigned. These model programs are now in operation and expect to continue through 1970 and beyond.

Details of the four plans, Team Teaching, Self-Contained Classroom, Departmentalization Content in Depth, and Specialist Teachers follow:

Team Teaching

In each of the intermediate teams, four teachers and two teacher aides are responsible for the instruction of 125 multi-aged students. Each team has curriculum area leaders chosen because of demonstrated strength in a specific area of the curriculum; they initiate and direct team planning in their area. Students are evaluated on performance, potential and social and emotional characteristics. Diagnostic tests help to determine each child's mathematics level. Team members work cooperatively to establish behavioral objectives, to plan the instructional materials and techniques and to allocate teaching responsibilities.

Self-Contained Classroom

The 10 teachers in this plan place value on creative teaching, on the discovery approach to learning and on individualized instruction. They view these emphases as dependent largely on the teacher's readiness and willingness to use new approaches, including the use of multi-dimensional learning materials.

Departmentalization: Content in Depth

Teachers in the departmentalized plan choose to teach mathematics and a second curriculum area on the basis of strength and interest in the subject areas. Relieved of the responsibility to teach other subjects, teachers feel

[1] Projected plans include adapting and applying successful procedures to the improvement of teaching and learning in the social studies and language arts areas.

they acquire a deeper knowledge of their chosen fields. The flexibility characterizing this plan permits small groups to function as needed and promotes independent study by pupils. A special assignment teacher makes released time for planning available to each teacher.

Specialist Teachers

Four former junior and senior high school teachers with degrees in mathematics serve as specialist teachers in this model program. Under this plan the teaching soon evolved into a cooperative venture with the regular classroom teacher and the specialist teacher working closely together in planning and executing the program.

Before instruction in the various organizational patterns began, all project teachers participated in an in-service workshop which focused on content and methods in modern mathematics. Stress was laid on (1) stating objectives in terms of observable pupil behavior, (2) selecting materials and activities which would contribute to the development of each specific objective and (3) developing the full potential of the individual student.

In addition to the general workshop, special workshops were held for teachers in the team teaching and departmentalized model school programs and for teacher aides. Four one-hour telelectures by outstanding educators on important aspects of successful team teaching programs were featured. Workshops were open to Greensboro supervisory personnel and to a limited number of district teachers and administrators outside the project schools. A resource center was set up for the use of all participants.

During the second summer of the project a two-week workshop was conducted with special consideration given to the teaching and learning process and new developments in mathematics and social studies. Four filmed lectures, followed by programed booklets for reinforcement, helped teachers learn to translate theory into classroom practice.

Analysis of data from questionnaires and observation of staff indicated: (1) support for the four model school programs by both parents and teachers though teachers were more supportive than parents of the team-teaching and specialist-teacher programs, (2) increased interest of teachers both within and outside the project schools in improving mathematics instruction, (3) special interest of principals in replicating the team-teaching program and (4) use of test results as diagnostic tools to improve instruction. Interest in moving toward ungraded programs in the primary grades and in providing in-service programs for the entire staff of certain nonproject schools were noted.

Based on research for the year 1968, the experimental schools produced results significant at the .01 level of confidence on the Contemporary Mathematics Test. The results of the evaluation to date indicate that the project has benefited students, teachers and observers who have been a part of the program.

Evaluation will include the final year of the project (1969-70). Elements of the four model school programs that prove to be worthwhile will be recommended for continuation in project schools and for introduction into other schools.

A Systems Approach to Improving Mathematics Instruction

A Systems Approach to Improving Mathematics Instruction (SAM) is an innovative curriculum materials package designed by teachers and central staff members of the Pittsburgh public schools to improve the mathematics achievement of low-achieving fourth grade pupils. The package provides the teacher with the following types of materials:

1. Forty sequential performance levels (basic steps) selected from the public school fourth grade mathematics course of study

2. Appropriate behavioral objectives for the low-achieving pupil for each performance level

3. A means to introduce motivationally each performance level

4. A means to diagnose pupils' learning needs in relation to each behavioral objective

5. A procedure to enable the teacher to differentiate instruction in accordance with pupils' needs for each behavioral objective

6. Sufficient resources to enable the teacher to differentiate instruction

7. A means to evaluate pupils' achievement with regard to each behavioral objective.

The system includes 43 films. Forty of these color sound films, about 10 minutes in length, were designed to introduce performance levels, to motivate children to learn the mathematics content and to develop favorable attitudes toward mathematics. The remaining three films supplement performance-level instruction. A film teacher and animated cartoon-like characters present the content in real life situations in which children are actively involved by means of a built-in oral response procedure. The children identify with the recurring film characters as they act out various mathematical situations with imaginative, amusing incidents and bits of magic.

Included in the package are the following support resources:

1. A project manual for teachers

2. Film discussion sheets to provide the teacher with suggestions for guiding class discussion before and after viewing a film

3. Two forms of a performance sheet for each performance level (The first form, a one-page test taken by each child following the viewing and discussion of the film, assists the teacher in diagnosing pupils' needs with regard to the behavioral objectives for the performance level. The second form is administered to the class following differentiated instruction to determine pupils' achievement.)

4. Differentiated lesson plan sheets which help the teacher organize the class for differentiated instruction and identify the instructional resources available.

5. Twenty 8mm color films in continuous loop cartridges about three minutes in length (With this resource pupils can reinforce basic skills and concepts by viewing the film individually or in small groups on a rear-view projection screen.)

6. Maintenance worksheets to facilitate the management of grouping and to reinforce concepts of a current or subsequent performance level

7. References to basic textbook and workbook pages related to each objective

8. Worksheets prepared by the staff to supplement the basic textbook and workbooks when additional follow-up material is necessary

9. Manipulative aides

10. Educational games

All instructional resources, including films, projectors and rear-view projection screens are permanently located in the schools. The work on a given performance level including introduction, diagnosis and differentiated instruction continues for approximately one week or until pupils demonstrate competence as measured by the performance sheet for the level. Then the cycle of activities is repeated with the next performance level in the sequence.

The program has been implemented in 12 public and six parochial school classes. During the developmental period, the mathematics consultant visits each teacher about once a week because current teachers are not all mathematics specialists. In fact, some of them are inexperienced classroom teachers with only limited preparation for implementing the system before becoming actively involved in the project. In-service meetings of staff and teachers are held monthly. These meetings and visits are responsible for most of the modif cations to improve the system or one of its components.

The first two years of the project, SAM, (1967-69) were spent in the development and revision of the system and its components and in trial run tests of feasibility. During the final year (1969-70), it will be modified to make it usable in any school and with any classroom organization.

Teachers report that their pupils are more interested in mathematics and are enjoying it more. The teachers prefer the program to other instructional procedures they have used because it does a better job of providing for the individual child. Their daily activities involve more extensive grouping, more flexibility in grouping and more individualization of instruction. During the 1969-70 school years, the effectiveness of the system in improving mathematics achievement and pupils' attitudes are undergoing more extensive evaluation as data are accumulated.

Among the possibilities for the future of the project are (1) expansion to other grade levels, (2) extension of the systems design to other subject areas and (3) production of the 16mm films for continuous loop cartridges to increase their effectiveness to individualized instruction.

Elementary School Developmental Mathematics Program

Elementary school personnel in Woodbury and five neighboring counties in Iowa are exploring ways of improving the teaching and learning of mathematics. Students, their teachers, parents and available experts are co-operating to develop, try out and evaluate various methods of instruction which will provide more adequately for the individual differences that exist in the classroom.

The self-contained and departmentalized classroom organization for elementary schools are prevalent in these counties. For this reason improvement in the learning and teaching of mathematics requires that teachers develop competence in individualizing instruction within these patterns as well as within those being used less frequently, such as team teaching.

The purpose of this developmental mathematics project is to provide each participating teacher with the assistance needed to (1) design and develop a program which will enable each child to progress at his own pace in terms of his potential, (2) demonstrate and test its feasibility in the classroom and (3) extend the plan through in-service education to other teachers in the schools represented. Thus, all teachers would be able to initiate and conduct programs using the interests, abilities and aptitudes of students as the basis for differentiated instruction.

The project began with a six-week workshop for 30 participating teachers (one from each cooperating school) during the summer of 1967. One half of each day was spent in content courses designed to develop mathematics background for the teacher and the other half in laboratory-type experiences focusing on the mathematics curriculum for children.

The workshop followed a two-week planning session for the project staff (director, coordinator and six team members.) At this time staff members familiarized themselves with elementary school mathematics texts and supplementary materials. They gathered information also on the educational background of participating teachers and the school situations in which these teachers would be working during the next school year.

For laboratory periods the six team members formed three teams of two members each to work with a group of 10 teachers representing grade levels one and two, three and four, or five and six. Together team members and teachers decided on appropriate mathematics topics to be developed for classroom use, set objectives, designed teaching procedures and pupil activities for each lesson, selected or developed materials, and planned ways of grouping children to meet individual differences.

At the end of the workshop each teacher had a notebook containing the topics developed with approximate dates on which each would be implemented during the following school year. With a duplicate of each notebook in the project office, the staff was able to maintain contact through the year by visitation, conferences, assistance with materials and evaluation of the different approaches. In addition they assisted in making decisions on which phases to incorporate into a developmental mathematics program for Woodbury and the five participating counties. Meetings throughout the school year accounted for exchange of ideas, discussion of problems and joint evaluation by teachers and staff.

This workshop process was repeated for another 30 participants during the second summer (1968). A sensitivity training course was added to help the teachers acquire more awareness of differences in children and to evolve means for coping with these differences in the development and implementation of a mathematics program.

A third workshop group of still another 30 participants is planned for the final year of the project (1969-70). The additional feature this year is a pilot project to effect an expansion of the program from one teacher in a school to the entire faculty as a joint effort of participants and the project staff. Other matters for consideration are the relative merits of in-service during the school year or a more concentrated summer in-service program.

Evidence of success of the project to date include teachers' reports of (1) improved attitudes toward their competence in teaching mathematics, (2) adaptation of the techniques learned in the teaching of other subjects, (3) greater knowledge of mathematics content, (4) more familiarity with and an increased use of supplementary teaching materials and (5) the favorable impressions of parents, administrators and professors of elementary education in the area.

An analysis of the entire testing program, giving grade-equivalent growth scores of students and reactions of teachers, parents, administrators and consultants to the first two years of the project will be available after the 1969-70 school year.

Southwest Missouri Educational Improvement Center

The Southwest Missouri Educational Improvement Center (SMEIC) encourages local school systems in the region to make critical studies of their instructional programs and to select areas in need of improvement. SMEIC then provides guidance and assistance to the school system in planning, designing and operating more effective programs.

A number of schools have selected elementary school mathematics as a major area of concern.[1] For these schools SMEIC provides curriculum and mathematics specialists to assist with workshops and other in-service programs and to help the schools establish model programs in elementary school mathematics. Colleges and universities and the Mid-Continent Regional Educational Laboratory in Kansas City are cooperating with SMEIC in these improvement programs.

A curriculum study by the local school delineates with consultant help the problems in mathematics. A written rationale explaining the problem and suggesting how it will be attacked is submitted to the SMEIC staff. The staff provides pre-pilot workshops and seminars when needed to help teachers develop background for the newer programs to be initiated and also consultative help when the pilot project goes into operation.

[1]Other schools are working on mathematics at grades 7 and 8 or 7-12 and on phases of the language arts at the elementary school level.

Together the SMEIC staff and participating teachers develop behavioral objectives for each level and model resource units as guides to classroom instruction. Using the behavioral objectives as a base, the center staff has developed a comprehensive diagnostic test for each level to help the teacher gain information on the pupil's mathematics background and to plan for the desired behavioral changes to be expected. Demonstrations of diagnostic procedures are held and follow-up activities cooperatively planned by the teacher and mathematics specialist. The center staff will also administer pretests and posttests as one means of evaluating the success of pilot projects.

The model resource units, designed to bring about change, are detailed on a daily lesson plan basis into specific objectives and content with suggested activities and support materials. The pilot tryouts determine which resource units have significant long range effect on success in mathematics and which require revision. Those which prove to be exemplary will be disseminated by the center staff to school districts in the region.

Implications for Mathematics Education

School staffs who feel the need to differentiate instruction for the various ability levels within a classroom but do not find it feasible to institute individualized instruction will find some ideas and suggestions in these four model programs. Each suggests ways of moving from a single text for the entire class to the use of differentiated materials for sub-groups within the class. They provide in-service for project teachers before the program begins and continuously throughout the operational phase.

All of the projects are producing materials which could be useful to other school systems desiring to make similar changes. For example, the Pittsburgh project will have a wealth of material in a variety of forms. While produced especially for slow-learning fourth-graders, adaptations may be made for other grade levels, for small groups and for individualized instruction.

These projects illustrate the effect that an experimental program can have on the total school system. Three of the project staffs report keen interest in improving their mathematics programs not only by control groups but also by schools not directly involved in the experiment. The operation of a multiplier effect is certainly a highly desired result; in fact, it is the basic reason for the experiments. It is also obvious, however, that as general improvement is made throughout the school system, the differences between the experimental schools or classes, their controls and those entirely outside the experiment will be lessened.

Another plus factor appears to be the influence of innovations in mathematics on other subject areas. Teachers who experience success with teach-teaching in mathematics begin to try the method with social studies.

Those who learn to differentiate instruction in mathematics see the possibilities for phases of the language arts. Teaching for discovery is found to be as applicable to science as for mathematics. Teachers not involved in the experiment ask for in-service assistance in learning the newer methods. Success breeds success for teachers and children alike.

Again innovation often leads to other innovations. Introducing team-teaching in a model school (Greensboro project) led teachers to design a type of reporting system that would more adequately inform parents of pupils' progress. Teachers participating in team-teaching find that multi-grading is taking place and the staff predict that multi-grading will gradually become an essential part of the team-teaching pattern.

A surprising result to those who hold that knowledge of mathematics content is the most important missing ingredient in improving elementary school mathematics is the fact that the students of specialist-teachers obtained lower mean scores on the standardized test than students in the other three model programs (Greensboro project) and that the self-contained classroom method produced the highest mean scores. Several points need to be kept in mind in interpreting these scores, however. It should be remembered that 1967-68 was the first year of the project and that early research may not reflect end-of-the-project results. The characteristics of the students should also be considered. The students in the self-contained classroom were from a wealthy suburban area and the students in the school in which mathematics specialists were involved, from a low socioeconomic background.

OVERALL IMPLICATIONS OF ESEA TITLE III PROJECTS FOR MATHEMATICS EDUCATION

Initiating New Programs

Changes in the mathematics program within a school system must be made in the framework of what exists, what is feasible in the total elementary school program and what is desirable for children. After these decisions are made, the sequence of steps in the defined direction must be determined.

The answer to what exists requires a status study of the current program; study of content, materials, methods; achievement of pupils in relation to potential; teachers' strength and weakness with regard to mathematics or phases of the subject, and other matters of concern to the particular school system.

The question of what is feasible in the total elementary school program necessitates a close look at priority needs. Rapidly occurring changes in all subject areas require continuous study with periodic emphasis to take care of new developments in each subject.

What is desirable for children demands examination of the mathematics knowledge to be acquired, the attitudes and aspirations to be developed and the materials to be used. Furthermore, the significant adults in the child's mathematics environment must acquire the background knowledge and teaching competence to assist him in his learning. Finally, a sequence of steps delineated from what is both practicable and desirable will serve as guideposts to improvement.

Guideposts to improvement are the Title III projects of this report. As they are examined to determine the different ways in which needs are assessed, directions determined and suitable procedures selected, the initiator of a new program will find it important to keep in mind that adaptation is usually more successful than replication. A wholesale transplant is not possible because the existing situation is not the same.

Modifications must be made to achieve a fit between what exists, what is desired and what is feasible in every situation. Most of these programs have features that would be innovative for some school systems but not for others though parts of many projects may be worthy of replication. Each school system assumes the responsibility of deciding which projects can make a contribution toward the achievement of its own goals and what modifications or adaptations will result in maximum benefit.

Once a new program in mathematics is introduced, time needs to be allowed for teachers to become familiar with the newer content, organization pattern, materials or methods. Time should be allowed also for the students to adapt to the new setup. Students make more progress each successive year in a new program according to an evaluation of the progress of junior high school students with School Mathematics Study Group Materials.

Accordingly, a promising new program should not be abandoned after a one-year evaluation. If there is no evidence that it is harmful to the children and if there is evidence that it is substantially as successful as the earlier one, the newer program should probably be given a chance to prove itself on a long-range basis. Therefore, it is essential that Title III projects continue as nearly intact as possible beyond the three-year period of federal funding. In fact, continuations are already being planned according to the directors, with extensions and expansions supported by the local school system if local and state funds can be made available for these purposes.[1]

Essential, too, for any new program is in-service education. Great importance has been placed on in-service training in ESEA Title III projects. Recognized as a necessary adjunct to the implementation of the programs here described, in-service education has been provided for two purposes: (1) to furnish mathematics background for teachers and (2) to familiarize them with the new organizational pattern, method, content, material, equipment or combination of these features.

Moreover, in-service opportunities should be made available to all personnel directly involved with the project — teachers, specialist teachers, principals, supervisors, teacher aides, volunteers and parents. Released time should be given these participants during the day for this training or compensation made for summer in-service not included in the school year.

These model projects offer many fruitful suggestions for improving in-service programs. For example, local school systems would do well to emulate their practice of developing teacher-leaders who go to other schools or universities for training and then return to their own schools to conduct in-service programs or demonstrate teaching techniques for their peers. By such means, teachers create the greatly needed multiplier effect — an effect to be encouraged if we hope to reach all elementary school teachers.

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[1] Hearn, Norman Eugene. Innovative Educational Programs: A Study of the Influence of Selected Variables upon Their Continuation Following the Termination of Three-Year ESEA Title III Grants. Doctoral Dissertation, George Washington University. September 1969. pp. 197-200; 225-226

Technology and New Programs

Today's school personnel will find themselves making decisions on whether it is desirable for their school systems to install computer programs for instructional use or for storage and retrieval purposes. They will find it necessary to decide whether to enter into individually prescribed instruction programs, to combine a variety of materials, methods, organizational patterns and human resources into workable systems or to achieve improvements in less spectacular ways that nevertheless indicate progress. Directions will be determined by an understanding of technological advances and their potentiality for improving instruction as well as knowledge of the current status of the school system and its possibilities for change.

Educational technology is often misinterpreted as being limited to the hardware used in education. On the contrary, the concept encompasses a system of interaction between people in the educational enterprise — teachers, administrators, aides, volunteers, parents and other participants; materials of instruction and equipment — hardware, such as computers and teaching machines, and software, such as programed instructional materials and books; and the environment — the combined learning resources of the school, home and community.

The system of interaction is designed and directed toward well defined objectives. Each person involved has specific responsibilities and each piece of material or equipment is selected or developed for its potential contribution to one or more objectives stated in terms of observable behavior. Some manipulation of the environment is often necessary for the success of the operation. For example, school organizational patterns may need modification and the library may be expanded to offer a variety of services contributing to the system.

As manager of the system, the teacher has an indispensable and highly significant dual role. The teacher is not only manager but the professional responsible for directing the learning of each child so that he makes maximum progress in relation to his potential. His management duties include leadership to support staff and responsibility for the selection, development, arrangement and management of the instructional materials. In the role of guide to the learning of pupils, the teacher diagnoses learning levels of pupils; evaluates and prescribes appropriate work for or with the child; provides continuous encouragement to children in becoming self-directive and independent; and recommends individual, group or tutorial work as needed.

To guide children's progress within a technological educational system, the teacher needs to know more about children than ever before. Their behavior, learning characteristics, motivations, potential, achievement and other matters affecting progress are of serious concern. His judgment as a professional is required to fit the learning experience to the child so that the delicate balance between the new and the familiar challenge him without undue frustration and wasteful repetition. To the teacher goes the responsibility for the system and its control.

Achievement of a systems approach to mathematics education is the goal toward which several of these projects are striving. Problems of individualization of instruction and utilization of teaching staff may thus be resolved. The IPI program at Monterey illustrates the progress of individual pupils through a continuous mathematics program. The Bowling Green project demonstrates alternate ways of achieving similar goals. Both projects recognize the importance of differentiated staff roles in an individualized program.

The CAI projects show a systems approach to a small segment of the total mathematics program. The drill and practice which follows the developmental work is carefully planned and sequenced to provide alternative routes based on continuous evaluation of results. Certainly, the Pittsburgh project has succeeded in developing a workable system for a particular target group of children.

Although the cost factor will undoubtedly prohibit many school systems from developing at present such programs as CAI and IPI, school personnel are obligated to become familiar with their possibilities (and their limitations) for improving education. Immediate improvements can be made in desirable directions if they gain a background knowledge of these programs. Some project staffs have thus discovered ways of adapting the facilitating patterns of organization for instruction and of staff utilization to other types of individualized programs. This sort of improvement can be made within their current budgets. Then, they can plan ahead for change requiring increased financial support.

Limitations of Preplanned Programs

What of the limitations educators see in computerized and completely preplanned programs? Their advantages have been highlighted in the summaries and discussions of projects, but what of their limitations? Are they real? If so, what can be done about them? Is there risk that mathematics may be treated as a tool subject with the false implication that as such it is best learned by repetitive drill? Yet, ample evidence is now available that the major proportion of time for learning mathematics should be given to the developmental phase with probably not more than one fourth to one third devoted to the repetitive type of practice and drill.[1]

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[1]Marilyn N. Suydam and C. Alan Riedesel. "Research Findings Applicable in the Classroom." The Arithmetic Teacher 16: December 1969, p. 641

And here is a limitation, a risk: Most of the materials available for individualized instruction are designed for drill and practice, rather than for concept development. The latter materials are more difficult to prepare. Until more and better materials for individualized instruction are available, school personnel may expect to prepare many of their own developmental materials. They may do well to consider combinations of group and individualized instruction in decision making on the appropriate combinations for a particular class.

Aside from limitations in regard to materials, there are other concerns. There is the fear in these preplanned programs that the less tangible, less measurable but important abilities will be neglected in the total mathematics program. For example, most educators feel that the ability to recognize and apply the mathematical knowledge to daily life situations, to learn about and appreciate the contributions of mathematics, to engage in creative and divergent thinking requires interaction with other students and knowledgeable adults.

Again, habits and attitudes of students pose a problematic outcome in preplanned programs. Granted that individualization encourages the development of a wholesome self-concept, of independence and self-direction in learning. Does it also instill in children, for whom mathematics presents an intellectual challenge, tolerance and compassion for those who find it difficult and dull. Does it lead to learning in cooperation with others? If it helps children to learn how to learn, does it also guide them to know what to do with learning?

And again. Does the step by step presentation of the preplanned program of bits of information enable the learner to process it or integrate it sufficiently well with knowledge already acquired that he can make it available when he needs it for future learning?

This review of the limitations of preplanned programs does not imply that textbook programs achieve the desired objectives. Indeed, they fall far short. But an understanding of the limitations will prod us into continuing the search for better ways of incorporating all significant objectives into mathematics education programs. Nor does the recognition of partially realized objectives indicate the desirability of an either-or situation. A computer, a film loop or a programed unit on a single topic can furnish background information to stimulate creative thinking; and the need for further individual study may arise from problems raised in a group discussion.

Assistance for New Programs

School systems will find it greatly to their advantage to become familiar with the resources available to them within the states, the region and the nation for improvement of their mathematics programs. Some states have set up centers to serve a section of the state. The Southwest Missouri Educational Improvement Center project illustrates one way the service center operates in working with a local school system. The Greensboro project demonstrates cooperation between Title III and V of ESEA; the problems identified are of concern to the entire state of North Carolina.

Some of the resource personnel for the projects are supplied by the research and development centers and regional education laboratories in the locality. Several of these laboratories are engaged in disseminating information about projects within their regions and with evaluation studies of them.[1]

The Greensburg project is an example of cooperation between ESEA Title III and the Pennsylvania Department of Education to test the feasibility of an information system developed mainly with state funds. Most of the in-service education projects have called upon the resources of colleges and universities for resource personnel. Visitation to established programs by school systems initiating similar programs and the use of resource personnel from operating projects to help the local school system launch its program have been demonstrated in several instances.

Not to be overlooked in efforts to improve mathematics instruction are the ideas, suggestions and materials which may be obtained from the experimental projects and demonstration programs. Some of them have received nationwide recognition and are influencing elementary school mathetics education today. Among them are: The Madison Project, The School Mathematics Study Group Project, The University of Illinois Arithmetic Project, The Minnemast Project, Patterns in Arithmetic, Stanford Brentwood Computer-Assisted Instruction Laboratory and the Nuffield Project developed in England. All of these are avenues to assistance for school systems undertaking mathematics improvement projects.

[1] See Appendix B.1-4 for lists and addresses referred to in this section of the report.

APPENDIX A

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APPENDIX B

PROJECT INFORMATION

Appendix B provides information which will be useful to school personnel who desire further details on a project summarized in the report. Two types of information are reported: (1) a list of materials available as reported by the project director and (2) names and addresses of the project director and the superintendent of schools for the district acting as legal agent for the project. These persons will serve as contacts for visitation requests, for materials and for specific information on a particular project.

IN-SERVICE EDUCATION

Use of Computer-Assisted Instruction for In-service Education for Elementary School Teachers

Materials available

1. A 30-minute sound film of the project
2. The original CAI course programed for a computer
3. A translation of the course for a different computer

Project Co-directors

Samuel M. Long, Assistant Superintendent, Williamsport Area School District, 845 Park Avenue, Williamsport, Pa. 17701

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Superintendent

Clyde H. Wurster, Superintendent, Williamsport Area School District, 845 Park Avenue, Williamsport, Pa. 17701

Improving Teaching Strategies Through Video-Taped Classroom Demonstrations

Materials available

1. A catalog, Films for Improving Teaching Strategies, contains a description of each film, time required and the teaching level of teachers for which each is appropriate.

2. Monthly Videobriefs (four-page reports on project activities)

    a. Vol. I., Nos. 1-8 (October 1966-May 67)

    b. Vol. II., Nos. 1-8 (October 1967-May 68)

    c. Vol. III., Nos. 1-8 (October 19668-May 69)

3. Kinescopes (16mm - for loan)

    a. Introduction to Multiplication

    b. Subtraction Involving Regrouping

    c. Mathematical Sentences and Statement Problems

    d. Dividing Fractions for Understanding

    e. Linear Measure

    f. Open and Closed Curves

    g. Points in Space

    h. Perimeters of Simple Closed Curves

    i. Curves

    j. Deductive Approach to Rectangular Area

    k. Discovering the Value of Pi

    l. Inductive Approach to Triangular Area

4. Brochure of the project

Project Director

W. E. Trahan, Director, ESEA Title III, The South Park Public Schools, Beaumont, Tex. 77705

Superintendent

R. A. Permenter, The South Park Public Schools, Beaumont, Tex. 77705

New Shoreham Tele-lecture Math Project

Materials available

1. Description of the project

2. Sample lesson plans

Project Director and Superintendent

Thomas McCabe, New Shoreham, R. I.

Project Adviser

Arthur McMahon, Consultant, Mathematics Education, Department of Education, Providence, R. I. 02904

Pennsylvania Retrieval of Information for Mathematics Education System (PRIMES) Regional Center

Materials available

1. Slide/tape, filmstrip/tape describing project (for loan)

2. Authority lists used to classify textbooks, tests, etc.

   a. Content

   b. Behavioral objectives

   c. Vocabulary

3. Book-form indexes for:
    a. Textbook series
    b. Standardized tests
    c. Films/filmstrips
4. Curriculum Procedures Manuals I-IV
5. Elementary School Mathematics - A Status Report - 1970 (free)
6. Research studies microfilm file, 1909-1968
7. Research studies monograph

Director of PRIMES State Project

Emanuel Berger, Box 911, Department of Education,
Harrisburg, Pa. 17126

Directors of PRIMES Regional Centers

Judith Cope, Westmoreland County School Board,
Greensburg, Pa. 15601

Everett Landin, Educational Development Center,
West Chester State College, West Chester, Pa. 19380

Program Development and In-service Training for Improvement of Curriculum Organization and Instruction in Carteret County North Carolina Schools

Materials available

1. Program Development Newsletters
   Vol. 1 #1 gives a description of the project
   Vol. 2 #2 describes ongoing and future project activities
2. Video tapes (for loan)
3. Other materials as developed by the project

Project Director

Douglas M. James, Courthouse Annex, Beaufort, N. C. 28516

A Program of Teaching Re-education for Curriculum Development

Materials available

1. Video tapes of micro teaching segments selected from demonstrations to be used for in-service education of teachers

2. Working guides for teachers

3. A report: "Reidsville Teachers Examine Themselves and their Practice after the First Summer of In-service Education"

   (A similar report will be prepared following the second year of the project.)

4. Part II. Narrative Report: Presents a summary of project objectives and procedures, interim results based on questionnaires and interviews and future project plans.

Project Director

J. W. Knight, Director of Special Projects for the Reidsville City Schools, 603 Piedmont Street, Reidsville, N. C. 27320

Superintendent

C. C. Lipscomb, Reidsville City Schools, 603 Piedmont Street, Reidsville, N. C. 27320

Prototype: Leadership Training Demonstrated Through a Program in Elementary School Mathematics Education

Materials available

1. Kinescopes of three one-hour television programs:
   Curriculum Development: How?
   New Ideas in Teaching Techniques
   Change and Innovation in Mathematics Teaching

2. Prototype: Leadership Training Program Demonstrated Through a Leadership Training Program in Elementary School Mathematics. The report contains a description of the project, the unique plans, accomplishments during the leadership workshop, and summaries of the implementation which followed in each local school during the 1967-68 school year for each of the participating teams.

Project Director

Clarence W. Bennett, Associate Professor of Mathematics, Boston State College, 625 Huntington Avenue, Boston, Mass. 02115 (formerly Director of Mathematics for the Brookline, Mass. Public Schools)

Superintendent

Richard I. Sperber, Brookline Public Schools, Town Hall, 333 Washington Street, Brookline, Mass. 02146

INDIVIDUALIZED INSTRUCTION

Computer Assisted Instruction in Mathematics

Materials available

1. Progress Report No. 1

2. Progress Report No. 2 (contains all published materials on the project, including 14 articles) October 1968

3. Progress Report No. 3, May 1969

Project Director and Superintendent

Julien D. Prince, McComb Municipal Separate School District, 695 Minnesota Avenue, McComb, Miss. 39648

Individual Computer Aided Instruction

Materials available

1. Brochures and Flyers

2. Progress Reports

3. Student Evaluation Reports

4. CAI Film available from: Title III, ESEA Coordinator, State Department of Education, Frankfort, Ky. 40601

Project Director

Edwin R. Jones, Eastern Kentucky Educational Development Corporation, Title III ESEA, 925 Winchester Avenue, Ashland, Ky. 41101

Superintendent

Oran C. Teeter, Paintsville Independent Schools, Box 152, Paintsville, Ky. 41240

Planning and Pilot Implementation of a Computer Based Instructional Program

Materials available

1. Brochures prepared by RCA

   RCA Instructional Systems, Instructional 70, Teachers Guide Summary, February 1968

2. CAI Another Tool for Education in the New York City Public Schools

3. Evaluation Report

Project Director

Cornelius Butler, 229 East 42nd Street, New York, N. Y. 10017

Director, New York City Center on Innovation

Shelly Umans, Board of Education, City of New York, 110 Livingston Street, Brooklyn, N. Y. 11201

Stanford-Ravenswood Computer-Assisted Instruction Project

Materials Available

1. Brochures

2. Films: "The Brentwood Story," a 14-minute, 16mm color and sound film on the Stanford-Brentwood CAI Laboratory presenting the laboratory operation, the mathematics and reading programs, the computer and its functions, lesson preparation, the role of proctors and evaluation data.

"Please Type Your Name," a 14-minute, 16mm color-sound film presents an overview of the CAI project. It includes brief descriptions of the McComb Mathematics project and the Stanford-Brentwood CAI laboratory.

Project Director

William Ryhensky, c/o Brentwood School, 2086 Clarke Street, East Palo Alto, Calif. 94303

Superintendent

John A Minor, Superintendent, Ravenswood City School District, 2160 Euclid Avenue, East Palo Alto, Calif. 94303

Individually Prescribed Instruction (Project for Educational Innovation)

Materials available

1. Charts of the complete IPI mathematics continuum for kindergarten through the sixth grade are available from: Director, Research For Better School, 1700 Market Street, Philadelphia, Pa. 19103

2. A 30-minute film on IPI "Rx for Learning" is available from William W. Matthews Co., Inc., 130 Seventh Street, Pittsburgh, Pa. 15222

3. First and Second Year Evaluation Report of the California demonstration project is available from George Washington University, West Coast Branch, Monterey, Calif., P.O. Box #5787, Presidio of Monterey 93940

4. A cost effectiveness analysis report of the project is available from Management Analysis Corporation, P. O. Box #521, Monterey, Calif. 93940

5. Bibliography of articles on IPI is available from: Director, Research for Better Schools, 1700 Market Street, Philadelphia, Pa. 19103

Project Director

Heloise Dales, Monterey County Office of Education, 132 W. Market Street, Salinas, Calif. 93940

Superintendent

Edwin C. Coffin, Monterey County Office of Education, 132 W. Market Street, Salinas, Calif. 93940

A Multi-Discipline Educational Center and Services

Materials available

1. A Newsletter which includes information on this project is available from: Director, Kentucky Innovative Development Center, 309 Ann Street, Frankfort, Ky. 40601

2. A film, "More Different Than Alike," is available from the NEA, 1201 16th Street, N.W., Washington, D. C. 20036 The Bowling Green Project is one of five different projects around which this film was developed.

3. Samples of the 86 Academic Learning Packages developed for Plaza A students (primary) and 61 for Plaza B students (upper elementary)

4. "Individualized Learning Center, Region 2, Title III ESEA," a brochure describing the project, is available from the director.

Project Director

O. A. Mattei, Project Director, McNeill Elementary School, Bowling Green, Ky. 42101

Superintendent

W. R. McNeill, Bowling Green Public Schools, 224 East 12th Street, Bowling Green, Ky. 42101

The Development of Four Model Elementary Programs for Teaching Mathematics with Implications for Other Instructional Areas

Materials available

From: Title III Project in Mathematics (Greensboro, N.C. 27402)

1. Title III Project in Mathematics: A Perspective. A 22-page bulletin contains descriptions and pictures of activities in model schools.

2. Bibliographies for Title III Project in Mathematics

   a. Instructional Aids and Materials for Mathematics

   b. Mathematics Films

   c. Professional Books

d. Readings in Current Journals

e. Elementary Mathematics Textbooks and Supplementary Materials

f. Organizational Patterns

g. Modern Mathematics

3. A film, Title III Project in Mathematics: A Perspective, provides an overview of the project and classroom activities of each of the model school programs.

   From: North Carolina Department of Public Instruction (Raleigh, N. C. 27602)

4. Mathematics Bulletin, North Carolina Department of Public Instruction

   June 1967 Informational article on the project

   October 1967 Article on the operational phase of the project

5. North Carolina Public School Bulletin, November 1967 Article with pictures

6. A series of four filmed lectures used in the project may be rented or purchased from: Special Purpose Films, 26740 Latigo Shore Drive, Malibu, Calif. 90265

7. Topics covered in the series are:

   Teacher Decision-making

   Motivation Theory for Teachers

   Reinforcement Theory for Teachers

   Retention Theory for Teachers

8. Programed booklets to be used in follow-up of films are available from: T. I. P. Publications, P. O. Box 514, El Segundo, Calif. 90245

Project Director

Sadie M. Moser, Greensboro Public Schools, Greensboro, N.C. 27402

Superintendent

W. J. House, Greensboro Public Schools, Greensboro, N.C. 27402

A Systems Approach to Improving Mathematics Education

Materials available

1. A packet of materials, including a description of the project, contains samples of performance sheets, film discussion sheets, differentiated lesson plan sheets, maintenance worksheets and a list of project films with descriptions of content

2. The completed curriculum/material package, including the films, will be available on some basis at the end of the project (by September 1970)

Project Director

Frank C. Schilling, 249 N. Craig Street, Pittsburgh, Pa. 15213

Director of Development

J. Edward Ricart, School District of Pittsburgh, Bellefield and Forbes Avenues, Pittsburgh, Pa. 15213

Elementary School Development Mathematics Program

Materials available

1. "Elementary School Developmental Mathematics Program, Woodbury County, Iowa" A two-page description of the project

2. "List of Current Materials:" Materials listed are available to participants of the summer workshops for examination and experimentation. On the basis of their study, teachers make decisions on equipment, aids, films, filmstrips, film loops, games, transparencies and tapes for their own classrooms

3. A 16mm documentary film of the project

4. Sample lesson plans

Project Director

David Grindberg, Room 508, Woodbury County Court House, Sioux City, Iowa 51101

Superintendent

D. J. Friedlund, Room 302, Woodbury County Court House, Sioux City, Iowa 51101

Southwest Missouri Educational Improvement Center

Materials available

1. Sample Resource Units in Mathematics

2. Sample Diagnostic Tests

3. Brochure of the Southwest Missouri Educational Improvement Center

Project Director

E. Leo Grebe, Director, Southwest Missouri Educational Improvement Center, 1001 W. Daugherty, Webb City, Mo. 64870

Mathematics Consultant

Jerry E. Smith, Southwest Missouri Educational Improvement Center, 1001 W. Daugherty, Webb City, Mo. 64870

APPENDIX C

PERSONNEL AND SERVICES AVAILABLE TO STATES, REGIONS AND OUTLYING AREAS

I. Title III Coordinators or Persons Responsible for Title III Programs

(Address inquiries to Coordinator, Title III, ESEA, unless an alternate title is designated)

State Department of Education
Montgomery, Ala. 36104

Director of Instructional Services
State Department of Education
Juneau, Alaska 99801

State Department of Public Instruction
Phoenix, Ariz. 85007

State Department of Education
Little Rock, Ark. 72201

State Department of Education
Sacramento, Calif. 95814

State Department of Education
Denver, Col. 80203

State Department of Education
Hartford, Conn. 06115

State Department of Education
Dover, Del. 19901

D. C. Public Schools
1411 K Street, NW, RM. 1444
Washington, D. C. 20005

State Department of Education
Tallahassee, Fla. 32304

Office of Instructional Services
State Department of Education
Atlanta, Ga. 30334

Office of the Superintendent
State Department of Education
Honolulu, Hawaii 96804

State Department of Education
Boise, Idaho 83702

State Department of Public Instruction
Springfield, Ill. 62706

State Department of Public Instruction
Indianapolis, Ind. 46204

State Department of Public Instruction
Kansas State Education Building
120 East 10th Street
Topeka, Kans. 66612

State Department of Education
Frankfort, Ky. 40601

State Department of Education
Baton Rouge, La. 70804

State Department of Education
Augusta, Me. 04330

State Department of Education
Baltimore, Md. 21201

State Department of Education
Boston, Mass. 02111

State Department of Public Instruction
Lansing, Mich. 48902

I. (cont'd)

Assistant to the Commissioner
State Department of Education
St. Paul, Minn. 55101

State Department of Education
Jackson, Miss. 39205

State Department of Education
Jefferson City, Mo. 65101

State Department of Public Instruction
Helena, Mont. 59601

State Department of Education
Lincoln, Nebr. 68509

Director of Federal Programs
State Department of Education
Carson City, Nev. 89701

State Department of Education
Concord, N. H. 03301

State Department of Education
Trenton, N. J. 08625

State Department of Education
Santa Fe, N. Mex. 87501

State Department of Education
Albany, N. Y. 12224

State Department of Public Instruction
Raleigh, N. C. 27602

State Department of Public Instruction
Bismarck, N. Dak. 58501

Director of Research
State Department of Education
Columbus, Ohio 43215

State Department of Education
310 Will Rogers Building
Oklahoma City, Okla. 73105

State Department of Education
Salem, Oreg. 97310

State Department of Education
Box 911
Harrisburg, Pa. 17126

State Department of Education
Providence, R. I. 02908

State Department of Education
Rutledge Building
Columbia, S. C. 29201

State Administrator
State Department of Public Instruction
Pierre, S. Dak. 57501

State Department of Education
Nashville, Tenn. 37219

Texas Education Agency
Austin, Tex. 78711

State Department of Public Instruction
Salt Lake City, Utah 84111

State Department of Education
Montpelier, Vt. 05602

State Board of Education
Richmond, Va. 32316

State Department of Public Instruction
Olympia, Wash. 98501

State Department of Education
Charleston, W. Va. 25305

State Department of Public Instruction
Madison, Wis. 53702

State Department of Education
Cheyenne, Wyo. 82001

Director of Education
Department of Education
Agana, Guam 96910

Director of Educational Development
Department of Education
Hato Rey, P. R. 00919

I. (cont'd)

Department of Education
Government of the Virgin Islands
P.O. Box 630, Charlotte Amalie
St. Thomas, V. I. 00801

Trust Territory of the Pacific Islands
Saipan, Mariana Islands 96950

Education Specialist
Bureau of Indian Affairs
1951 Constitution Avenue, N.W.
Washington, D. C. 20242

Department of Education
Pago Pago
American Samoa 96920

II. Regional Educational Laboratories

Appalachia Educational Laboratory (AEL)
1414 Kanawha Boulevard
Charleston, W. Va. 25325

Center for Urban Education (CUE)
105 Madison Avenue
New York, N. Y. 10016

Central Midwestern Regional Educational
Laboratory (CEMREL)
10646 St. Charles Rock Road
St. Ann, Mo. 63074

Eastern Regional Institute for
Education (ERIE)
635 James Street
Syracuse, N. Y. 13203

Education Development Center (EDC)
55 Chapel Street
Newton, Mass. 02160

Far West Laboratory for Educational
Research and Development (FWLERD)
Claremont Hotel
1 Garden Circle
Berkeley, Calif. 94705

Mid-Continent Regional Educational
Laboratory (McREL)
104 East Independence Avenue
Kansas City, Mo. 64108

Northwest Regional Educational
Laboratory (NWREL)
400 Lindsay Building
710 Southwest Second Avenue
Portland, Oreg. 97204

Regional Education Laboratory for
the Carolinas and Virginia (RELCV)
Mutual Plaza
Durham, N. C. 27701

II. (cont'd)

Research for Better Schools, Inc. (RBS)
121 South Broad Street
Philadelphia, Pa. 19107

Southeastern Education Laboratory (SEL)
3450 International Boulevard
Hapeville, Ga. 30054

Southwest Educational Development
Laboratory (SWEDL)
800 Brazos Street
Austin, Tex. 78767

Southwest Regional Laboratory for
Educational Research and Development (SWRL)
11300 LaCienega Bouldvard
Inglewood, Calif. 90304

Southwestern Cooperative Educational
Laboratory (SWCEL)
117 Richmond Drive, N.E.
Albuquerque, N. Mex. 87106

Upper Midwest Regional Educational
Laboratory (UMREL)
1640 East 78th Street
Minneapolis, Minn. 55423

III. Research and Development Centers

Center for the Advanced Study
of Educational Administration
147B Hendricks Hall
University of Oregon
Eugene, Oreg. 97403

Center for Research and Development
in Higher Education
University of California
4606 Tolman Hall
Berkeley, Calif. 94720

Center for Study of Evaluation
in Instruction Programs
University of California
145 Moore Hall
405 Hilgard Avenue
Los Angeles, Calif. 90024

Center for Research and
Development in Teaching
Stanford University
770 Welch Road
Palo Alto, Calif. 94304

The Learning Research and
Development Center
208 M. I. Building
University of Pittsburgh
Pittsburgh, Pa. 15213

R & D Center for
Educational Stimulation (3-12)
Fain Hall
University of Georgia
Athens, Ga. 30601

R & D Center for Social
Organization of Schools
Johns Hopkins University
3505 North Charles Street
Baltimore, Md. 21218

R & D Center for Teacher
Education
303 Sutton Hall
University of Texas
Austin, Tex. 78712

Wisconsin R & D Center for
Cognitive Learning
University of Wisconsin
1404 Regent Street
Madison, Wis. 53706

IV. Mathematics Curriculum Projects

The curriculum projects listed continue to have a national impact on matnematics education by involving many teachers and other school personnel in experimental and demonstration work, in their effect on textbook development and on preservice and in-service education.

All of the projects have produced materials for teachers including teachers manuals and guides, films and dissemination material for professional educators and the lay public. Most of them also offer instructional materials for children.

Listed for each project are the project title, director and address. Each of these projects will send free upon request sample kits of materials including brochures and newsletters of the project, reprints of articles and lists of materials available for loan or purchase. In some instances, project trained personnel assist local school systems with in-service work.

THE GREATER CLEVELAND MATHEMATICS PROGRAM OF THE EDUCATIONAL RESEARCH COUNCIL OF AMERICA (GCMP)

Director: John F. Mehegan
Address : Rockefeller Building
614 Superior N.W.
Cleveland, Ohio 44113

THE MADISON PROJECT

Director: Robert B. Davis
Address : Distribution Center for Project Materials:
Smith Hall, Syracuse University
Syracuse, N. Y. 13210

MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

Director: James H. Werntz, Jr.
Address : Minnemath Center
720 Washington Avenue, S.W.
University of Minnesota
Minneapolis, Minn. 55414

PATTERNS IN ARITHMETIC

Director: H. Van Engen
Address : Research and Development Center for Cognitive Learning
1404 Regent Street
Madison, Wis. 53706

IV. (cont'd)

SCHOOL MATHEMATICS STUDY GROUP (SMSG)

Director: Edward G. Begle
Address : Cedar Hall
Stanford University
Stanford, Calif. 94305

STANFORD BRENTWOOD COMPUTER - ASSISTED INSTRUCTION LABORATORY

Director: Patrick Suppes and Richard C. Atkinson
Address : Institute for Mathematical Studies in the Social Sciences
Ventura Hall
Stanford University
Stanford, Calif. 94305

UNIVERSITY OF ILLINOIS ARITHMETIC PROJECT

Director: David A. Page
Address : Education Development Center
372 Main Street
Watertown, Mass. 02172

V. ERIC

An Educational Resources Information Center (ERIC) for Mathematics has been established as a part of the Science Education Information Analysis Center (SEIAC) at Ohio State University. The ERIC clearinghouse for mathematics will collect research reports, program descriptions, speeches and other documents on mathematics education.

Materials collected will be available for purchase in printed form or in microfiche copy. Address inquiries to:

F. Joe Crosswhite
Associate Director for Mathematics
SEIAC
1460 West Lane Avenue
Columbus, Ohio 43221